Agenda Date: 5/24/23
Agenda Item: 8B

STATE OF NEW JERSEY

Board of Public Utilities
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www.nj.gov/bpu/

CLEAN ENERGY AND ENERGY

IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, C. 17, THE NEW JERSEY CLEAN ENERGY ACT OF 2018, REGARDING THE ESTABLISHMENT OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS	ORDER DIRECTING THE UTILITIES TO PROPOSE SECOND TRIENNIUM ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS
IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, C. 17, THE NEW JERSEY CLEAN ENERGY ACT OF 2018, REGARDING THE SECOND TRIENNIUM OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS	DOCKET NO. QO19010040 DOCKET NO. QO23030150
IN THE MATTER OF ELECTRIC PUBLIC UTILITIES AND GAS PUBLIC UTILITIES OFFERING ENERGY EFFICIENCY AND CONSERVATION PROGRAMS, INVESTING IN CLASS I RENEWABLE ENERGY RESOURCES AND OFFERING CLASS I RENEWABLE ENERGY PROGRAMS IN THEIR RESPECTIVE SERVICE TERRITORIES ON A REGULATED BASIS, PURSUANT TO N.J.S.A. 48:3-98.1 AND N.J.S.A. 48:3-87.9 – MINIMUM FILING REQUIREMENTS	DOCKET NO. QO17091004

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BY THE BOARD:

By this Order, the New Jersey Board of Public Utilities ("Board" or "BPU") directs each electric public utility and gas public utility in the State of New Jersey to propose energy efficiency ("EE")[1] programs for the second three-year cycle of programs ("Triennium 2") implemented pursuant to the New Jersey Clean Energy Act of 2018 ("CEA").[2]

This Order pertains to certain, but not all, aspects of the EE Triennium 2 framework due to the need to take sufficient time to develop a thoughtful, comprehensive framework while being cognizant of the benefits of affording the electric and gas public utilities sufficient time to develop their program proposals, including in coordination with each other, in preparation for Triennium 2. It is the Board's intention to address the aspects of the EE Triennium 2 framework that are not included herein in the near future and that are marked as "reserved" below – namely, goals, targets, performance incentive mechanism, building decarbonization start-up programs, and demand response programs – through a consolidated set of requirements and guidance.

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[1] As noted by the U.S. Department of Energy, "[e]nergy efficiency is the use of less energy to perform the same task or produce the same result. Energy-efficient homes and buildings use less energy to heat, cool, and run appliances and electronics, and energy-efficient manufacturing facilities use less energy to produce goods. https://www.energy.gov/eere/energy-efficiency.

[2] L. 2018, c. 17 (N.J.S.A. 48:3-87.8 et seq.).

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INTRODUCTION

State Legal and Policy Authorities and Drivers

On May 23, 2018, Governor Murphy signed the CEA into law. The CEA called for a significant overhaul of New Jersey's energy systems while growing the economy, building sustainable infrastructure, creating well-paying local jobs, reducing carbon emissions, and improving public health to ensure a cleaner environment for current and future residents. The CEA plays a key role in achieving the State's goal of 100% clean energy by establishing aggressive energy reduction requirements, among other clean energy strategies. This action by the Governor came at a critical time in our global fight against climate change and set New Jersey on a path to once again be a leader in charting a course towards a greener future.

The CEA emphasizes the importance of EE and peak demand reduction ("PDR") and calls upon New Jersey's electric and gas public utilities to play an increased role in delivering EE and PDR programs to customers.[3] The Act requires each Utility in the State to reduce the use of electricity and natural gas in its service territory. Specifically, the CEA directs the BPU to require:

> (a) each electric public utility to achieve, within its territory by its customers, annual reductions of at least 2% of the average annual electricity usage in the prior three years within five years of implementation of its electric energy efficiency program; and
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> (b) each natural gas public utility to achieve, within its territory by its customers, annual reductions in the use of natural gas of at least 0.75% of the average annual natural gas usage in the prior three years within five years of implementation of its gas energy efficiency program.[4]

The CEA also called for the Board to adopt programs that "ensure universal access to energy efficiency measures, and serve the needs of low-income communities . . . ."[5]

While the CEA is one of the primary drivers of EE programs in New Jersey, multiple other State laws and policy authorities guide the Board's establishment and continued development of the framework for these programs. New Jersey must not only meet targets set forth in the CEA but do so in a way that is consistent with the principles and goals of the following State laws and other authorities.

On July 6, 2007, the State enacted the Global Warming Response Act ("GWRA"), L. 2007, c. 112, which established a statewide goal of reducing greenhouse gas ("GHG") emissions to 80% below 2006 levels by 2050. On July 23, 2019, Governor Murphy signed into law L. 2019, c. 197, which reinforced the GWRA by requiring action in the short-term to better enable the State to meet its GHG reduction goal. In October 2020, the New Jersey Department of Environmental Protection's

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[3] New Jersey's electric and gas public utilities include Atlantic City Electric Company ("ACE"), Butler Power and Light Company ("Butler"), Elizabethtown Gas Company ("Elizabethtown"), Jersey Central Power & Light Company ("JCP&L"), New Jersey Natural Gas Company ("NJNG"), Public Service Electric and Gas Company ("PSE&G"), Rockland Electric Company ("RECO"), and South Jersey Gas Company ("SJG") (individually, "Utility"; collectively, "Utilities").

[4] N.J.S.A. 48:3-87.9(a).

[5] N.J.S.A. 48:3-87(g)–(h).

GWRA 80x50 Report found that, without steep and permanent reductions in GHG emissions, New Jersey will increasingly experience significant adverse effects of climate change.[6] On November 10, 2021, Governor Murphy signed Executive Order No. 274, setting a policy for the State of reducing GHG emissions to 50% below 2006 levels by 2030, to complement the GWRA's goal.[7]

On January 27, 2020, pursuant to Executive Order 28,[8] the Board released New Jersey's 2019 Energy Master Plan ("EMP"), which provided a comprehensive blueprint for an equitable and smooth transition from reliance on fossil fuels that contribute to climate change to 100% clean energy sources on or before January 1, 2050.[9] The EMP defines 100% clean energy to mean 100% carbon-neutral electricity generation and maximum electrification of the transportation and building sectors to meet or exceed the GWRA emissions reductions.[10] Maximizing EE and conservation and reducing peak demand (Strategy 3) and reducing energy consumption and emissions from the building sector (Strategy 4) are among the seven (7) key strategies identified in the EMP. These strategies play an essential role in meeting the State's long-term clean energy goals, including advancing building electrification. The EMP found that building space and water heating, appliances, and industrial uses are responsible for 28% of State emissions and 62% of the State's total end-use energy consumption; identified electrification as a significantly more cost-effective means of meeting emissions targets than switching to carbon-neutral fuels; and called for electrification of 90% of building space and water heating by 2050, with an early focus on new construction and the electrification of oil- and propane-fueled buildings.[11]

On January 20, 2023, Governor Murphy announced that the State would begin planning for the development of a new EMP for release in 2024 that will update and expand on the pathway to achieving a 100% clean energy economy by 2050 set forth in the 2019 EMP.[12]

[6] New Jersey's Global Warming Response Act 80x50 Report ("GWRA 80x50 Report") (2020), at 5, *available at* https://www.nj.gov/dep/climatechange/docs/nj-gwra-80x50-report-2020.pdf

[7] Exec. Order No. 274 (Nov. 10, 2021), 53 N.J.R. 2105(b) (Dec. 20, 2021), ¶ 25.

[8] Exec. Order No. 28 (May 23, 2018), 50 N.J.R. 1394(b) (June 18, 2018), ¶ 3.

[9] https://www.nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf .

[10] Id. at 11.

[11] Id. at 13. The EMP noted that, for example, more than 85% of New Jersey homes are heated with natural gas, oil, or propane. Id. at 149. In addition, the Board's August 2022 New Jersey EMP Ratepayer Impact Study incorporated the findings of the EMP into a comprehensive model of customer rate and energy cost impacts. The study found that, if the State continues to follow the approach laid out in the EMP, retail natural gas sales will fall by 25% by 2030, and an average residential customer will pay 25–30% more for natural gas heat and have higher overall non-vehicle energy costs in 2030 than in 2020, while a customer adopting EE and electric heating will have lower overall non-vehicle energy costs.

[12] "Governor Murphy Announces Planning for New 2024 Energy Master Plan," https://www.nj.gov/governor/news/news/562023/approved/20230120a.shtml.

On February 15, 2023, Governor Murphy signed three (3) executive orders.

- Executive Order No. 315 ("EO 315") set a goal that 100% of the electricity sold in the State be derived from clean sources of electricity by January 1, 2035, including through clean energy market mechanisms.[13] EO 315 also directed the Board to make updates to the EMP consistent with the new 2035 goal and provide specific proposals to be implemented both in the short-term and longer-term to achieve this goal.[14]

- Executive Order No. 316 ("EO 316") directed that "[i]t is the policy of the State to advance the electrification of commercial and residential buildings with the goal that, by December 31, 2030, 400,000 additional dwelling units and 20,000 additional commercial spaces and/or public facilities statewide will be electrified, and an additional 10 percent of residential units serving households earning less than 80 percent of area median income will be made ready for electrification through the completion of necessary electrical repairs and upgrades."[15] EO 316 defined electrification as "the retrofitting or construction of a building with electric space heating and cooling and electric water heating systems."[16]

- Executive Order No. 317 directed the Board to initiate a proceeding to engage with stakeholders and develop recommendations concerning decarbonization of the natural gas industry.[17]

Energy Efficiency Triennium 1

On October 11, 2018, PSE&G filed a petition with the Board requesting approval of its Clean Energy Future- Energy Efficiency ("CEF-EE") Program.

By Order dated June 10, 2020, the Board approved a transition framework for EE programs implemented pursuant to the CEA, including requirements for the Utilities to establish programs that reduce the use of electricity and natural gas within their territories.[18] In the June 2020 Order, the Board directed New Jersey's remaining electric and gas companies to submit their first respective three-year filings for EE and PDR programs by September 25, 2020 for Board approval by May 1, 2021 and implementation beginning July 1, 2021.[19] Also in the June 2020 Order, the Board directed Board Staff ("Staff") to return with recommendations specific to Butler by December 31, 2020.

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[13] Exec. Order No. 315 (Feb. 15, 2023), 55 N.J.R. 509(a) (Mar. 20, 2023), ¶ 26, available at https://www.nj.gov/infobank/eo/056murphy/pdf/EO-315.pdf.

[14] Id. ¶ 27.

[15] Exec. Order No. 316 (Feb. 15, 2023), 55 N.J.R. 510(a) (Mar. 20, 2023), ¶ 17, available at https://nj.gov/infobank/eo/056murphy/pdf/EO-316.pdf.

[16] Ibid.

[17] Exec. Order No. 317 (Feb. 15, 2023), 55 N.J.R. 511(a) (Mar. 20, 2023), ¶ 23, available at https://www.nj.gov/infobank/eo/056murphy/pdf/EO-317.pdf.

[18] In re the Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket Nos. QO19010040, QO19060748, and QO17091004, Order dated June 10, 2020 ("June 2020 Order").

[19] Id. at 38.

By Order dated August 24, 2020, the Board adopted the first New Jersey Cost Test ("NJCT") and directed the Utilities to use it to perform benefit-cost analyses during Triennium 1.[20]

By Order dated September 23, 2020, the Board approved a stipulation of settlement authorizing PSE&G to implement its CEF-EE Program.[21]

On September 25, 2020, ACE, ETG, JCP&L, NJNG, RECO, and SJG filed petitions with the Board requesting approval of their respective EE programs. On March 3, 2021, the Board issued an Order approving a stipulation of settlement for NJNG's SAVEGREEN 2020 Program.[22] On April 7, 2021, the Board issued Orders approving stipulations of settlement for the ETG and SJG programs.[23] On April 27, 2021, the Board issued Orders approving stipulations of settlement for ACE and JCP&L, and on June 9, 2021, the Board issued an Order approving a stipulation of settlement for RECO.[24]

By Order dated December 16, 2020, the Board directed Staff and Butler to work collaboratively with the New Jersey Division of Rate Counsel ("Rate Counsel") and the investor-owned electric and gas utilities, as applicable, to develop a proposal for Butler's EE and PDR programs and for Butler to file a petition by October 1, 2021. [25]

By Order dated March 24, 2021, the Board approved a contract for a Statewide Evaluator ("SWE") of New Jersey's EE and PDR programs.[26]

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[20] In re the Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs; In re the Clean Energy Act of 2018 – New Jersey Cost Test, BPU Docket Nos. QO19010040 and QO20060389, Order dated August 24, 2020 ("NJCT Order").

[21] In re the Petition of Public Service Electric and Gas Company for Approval of Its Clean Energy Future – Energy Efficiency ("CEF-EE") Program on a Regulated Basis, BPU Docket Nos. GO18101112 and EO18101113, Order dated September 23, 2020.

[22] In re the Petition of New Jersey Natural Gas Company for Approval of Energy Efficiency Program and the Associated Cost Recovery Mechanism Pursuant to the Clean Energy Act, N.J.S.A. 48:3-87.8 et seq. and 48:3-98.1 et seq., BPU Docket Nos. QO19010040 and GO20090622, Order dated March 3, 2021.

[23] In re the Petition of Elizabethtown Gas Company for Approval of New Energy Efficiency Programs and Associated Cost Recovery Pursuant to the Clean Energy Act and the Establishment of a Conservation Incentive Program, BPU Docket No. GO20090619, Order dated April 7, 2021; In re the Petition of South Jersey Gas Company for Approval of New Energy Efficiency Programs and Associated Cost Recovery Pursuant to the Clean Energy Act, BPU Docket No. GO20090618, Order dated April 7, 2021.

[24] In re the Petition of Atlantic City Electric Company for Approval of an Energy Efficiency Program, Cost Recovery Mechanism, and Other Related Relief for Plan Years One Through Three, BPU Docket No. EO20090621, Order dated April 27, 2021; In re the Verified Petition of Jersey Central Power & Light Company for Approval of JCP&L's Energy Efficiency and Conservation Plan Including Energy and Peak Demand Reduction Programs (JCP&L EE&C), BPU Docket No. EO20090620, Order dated April 27, 2021; In re the Petition of Rockland Electric Company for Approval of Its Energy Efficiency Program and Peak Demand Reduction Programs, BPU Docket No. EO20090623, Order dated June 9, 2021.

[25] In re the Implementation of L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, Butler Electric, BPU Docket Nos. QO19010040 & QO20100684, Order dated December 16, 2020.

[26] In re a Contract for a Statewide Evaluator of New Jersey's Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO20110700, Order dated March 24, 2021.

By Order dated September 14, 2021, the Board extended the deadline for Butler to file a petition by October 1, 2022.[27] On September 20, 2022, PSE&G filed a letter petition to extend the term of the 10 subprograms of the CEF-EE Program for a nine-month period (October 1, 2023 through June 30, 2024) in order to align the program with the three-year program cycle authorized by the Board for the other utilities ("CEF-EE Extension Program"). Additionally, the petition proposed offering PSE&G's electric CEF-EE programs to PSE&G gas customers who are also Butler customers during the nine-month extension period. On October 10, 2022, the Board issued an Order determining that PSE&G's CEF-EE petition filed on September 20, 2022 satisfied Butler's requirement.[28]

On November 8, 2021, ACE, ETG, JCP&L, NJNG, PSE&G, RECO, and SJG (collectively, "Petitioners") filed a joint letter petition with the Board requesting approval to implement a proposed joint utility solution to address budget constraints experienced during Triennium 1. On August 17, 2022, the Board approved a stipulation of settlement executed by the Petitioners, Rate Counsel, and Staff, which resolved the Petitioners' requests related to the November 8, 2021 joint letter petition.[29]

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[27] In re the Implementation of L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, Butler Electric, BPU Docket Nos. QO19010040 and QO20100684, Order dated September 14, 2021.

[28] In re the Implementation of L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, Butler Electric, BPU Docket Nos. QO19010040 & QO20100684, Order dated October 12, 2022.

[29] In re the Implementation of L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs; In re the Petition of Atlantic City Electric Company for Approval of an Energy Efficiency Program, Cost Recovery Mechanism and Other Related Relief for Plan Years One Through Three; In re the Petition of Elizabethtown Gas Company for Approval of New Energy Efficiency Programs and the Associated Cost Recovery Mechanism Pursuant to the Clean Energy Act and the Establishment of a Conservation Incentive Program; In re the Verified Petition of Jersey Central Power & Light Company for Approval of JCP&L's Energy Efficiency and Conservation Plan Including Energy Efficiency and Peak Demand Reduction Programs (JCP&L EEC); In re the Petition of New Jersey Natural Gas Company for Approval of Energy Efficiency Program and the Associated Cost Recovery Mechanism Pursuant to the Clean Energy Act, N.J.S.A. 48:3-87.8 et seq. and 48:3-98.1 et seq.; In re the Petition of Public Service Electric and Gas Company for Approval of Its Clean Energy Future - Energy Efficiency ("CEF-EE") Program on a Regulated Basis; In re the Petition of Rockland Electric Company for Approval of Its Energy Efficiency Program and Peak Demand Reduction Programs; In re the Petition of South Jersey Gas Company for Approval of New Energy Efficiency Programs and the Associated Cost Recovery Pursuant to the Clean Energy Act, BPU Docket Nos. QO19010040, EO20090621, GO20090619, EO20090620, GO20090622, GO18101112, EO18101113, EO20090623, & GO20090618, Order dated August 17, 2022.

By Order dated November 9, 2022, the Board approved updates and revisions to the Triennium 1 EE framework regarding the following topics: use of a "Low-income Lifetime Savings" metric; Staff's recommendations related to the Utilities' offering eligible PDR resources into the PJM Interconnection, LLC ("PJM") forward capacity market ("FCM") such that net revenues from cleared resources are used to offset revenue requirements of the Utilities' EE programs; renaming the Protocols to Measure Resource Savings as the Technical Reference Manual ("TRM"); Utilities' energy savings reporting; and development of a comprehensive update of the TRM for the Board's consideration ahead of the commencement of Triennium 2 EE programs.[30]

On January 19, 2023, the Utilities and Board executed a Non-Disclosure Agreement ("NDA") under Docket No. QO19010040 to facilitate the exchange of confidential information that a Utility or the Utilities, or its or their agents, may be requested or required to provide to the Board, Staff, and/or its vendors in connection with that docket and in order to comply with the CEA's directives to evaluate, measure, and verify Utility energy usage reduction, PDRs, and the Utilities' EE programs or research related to such.

Review of the first program year (July 1, 2021 – June 30, 2022) after the transition of EE programs pursuant to the CEA shows the following aggregated, statewide results by New Jersey's Clean Energy Program ("NJCEP") EE programs, Utility EE programs established pursuant to the CEA, and other Utility "legacy" EE programs:[31]

- Budgets: $1.02 billion
- Expenditures: $501 million, including $241 million in incentives
- Electric savings: 138,480 kilowatts ("kW") of demand savings, 1,067,697 megawatt hours ("MWh") of annual savings, and 14,763,458 MWh of lifetime savings
- Gas savings: 2,907,504 MMBtu of annual savings and 27,549,801 MMBtu of lifetime savings.

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[30] In re the Implementation of L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs; In re the Petition of Atlantic City Electric Company for Approval of an Energy Efficiency Program, Cost Recovery Mechanism and Other Related Relief for Plan Years One Through Three; In re the Petition of Elizabethtown Gas Company for Approval of New Energy Efficiency Programs and the Associated Cost Recovery Mechanism Pursuant to the Clean Energy Act and the Establishment of a Conservation Incentive Program; In re the Verified Petition of Jersey Central Power & Light Company for Approval of JCP&L's Energy Efficiency and Conservation Plan Including Energy Efficiency and Peak Demand Reduction Programs (JCP&L EEC); In re the Petition of New Jersey Natural Gas Company for Approval of Energy Efficiency Program and the Associated Cost Recovery Mechanism Pursuant to the Clean Energy Act, N.J.S.A. 48:3-87.8 et seq. and 48:3-98.1 et seq.; In re the Petition of Public Service Electric and Gas Company for Approval of Its Clean Energy Future - Energy Efficiency ("CEF-EE") Program on a Regulated Basis; In re the Petition of Rockland Electric Company for Approval of Its Energy Efficiency Program and Peak Demand Reduction Programs; In re the Petition of South Jersey Gas Company for Approval of New Energy Efficiency Programs and the Associated Cost Recovery Pursuant to the Clean Energy Act, BPU Docket Nos. QO19010040, EO20090621, GO20090619, EO20090620, GO20090622, GO18101112, EO18101113, EO20090623, & GO20090618, Order dated November 9, 2022.

[31] The 4Q FY22 Statewide Report includes more detailed results and is *available at* https://www.njcleanenergy.com/main/public-reports-and-library/financial-reports/clean-energy-program-financial-reports. Individual utility annual reports, available on the same webpage, provide detailed information about program implementation and outcomes, including cost-effectiveness, performance targets, and equity metrics. Utility quarterly reports are also available on the same webpage.

- Annual emissions reductions: 817,352 metric tons of carbon dioxide, 1,500 metric tons of nitrogen oxide, 325 metric tons of sulfur dioxide, and 1,174 grams of mercury
- Lifetime emissions reductions: 10,839,794 metric tons of carbon dioxide, 15,963 metric tons of nitrogen oxide, 4,496 metric tons of sulfur dioxide, and 16,240 grams of mercury

Energy Efficiency Triennium 2 and New Jersey's 100% Clean Energy Future

Given the State's new goals of achieving 100% clean energy by 2035 and new targets to advance electrification in commercial and residential buildings, Staff seeks through the Triennium 2 EE framework to maximize EE in buildings while also preparing the groundwork to make significant strides in the electrification and, ultimately, decarbonization of the building sector.

Using energy more efficiently is one of the easiest and most cost-effective strategies in our fight against the global climate crisis. EE programs are available for all sectors and offer a wide variety of targeted incentives for residents and businesses with varying needs throughout the State. EE helps to reduce GHG emissions and other pollutants and mitigate climate impacts, thereby providing health benefits, while bolstering the economy. EE is the largest energy sector in New Jersey, employing over 34,500 people and supporting more than 4,700 EE businesses.[32] EE projects are labor intensive, and increased achievement of EE will greatly strengthen the job market. EE projects also reduce energy use and can reduce energy costs for consumers, allowing those consumers to use those funds elsewhere, including injecting them back into the economy.

New Jersey's EE framework has the following primary objectives:

- Afford access to EE programs for all market segments and for all New Jersey residents and businesses, regardless of geographic location, including through energy-efficient improvements that support New Jersey's path toward decarbonization;
- Decrease energy burdens for all ratepayers, with a specific focus on increasing affordability for lower-income customers and those living in disadvantaged, environmental justice, or overburdened communities ("OBCs");[33]
- Ensure that low- and moderate-income ("LMI") communities and OBCs share the same level of access to the benefits associated with EE investments as wealthier communities;
- Continue to increase accountability and reporting of spending and savings related to EE and peak demand reduction;
- Reduce costs for energy saved through reliable and consistent program delivery;
- Reduce administrative costs passed through to ratepayers; and
- Expand job opportunities and increased economic benefits of EE for New Jersey.

[32] E2, New Jersey: Energy Efficiency Jobs in America (2022), *available at* https://e4thefuture.org/wp-content/uploads/2022/12/New-Jersey_2022.pdf.

[33] See the following webpage for the identification of and more information about OBCs: https://dep.nj.gov/ej/communities. The framework for New Jersey EE programs seeks to reduce the inequity currently experienced by groups and individuals across New Jersey who disproportionately lack access to energy-efficient housing, appliances, and technologies. The lack of access is often reflected in a household's energy burden. Research shows that the average low-income household devotes more than three times more of their income to energy bills than the average non-low-income household. See https://www.energy.gov/eere/slsc/low-income-community-energy-solutions. Families who face higher energy burdens experience many negative long-term effects.

EE remains both an immediate and long-term component of reducing energy costs and improving health and safety for all households. Moreover, EE must be integrated seamlessly with other government efforts to promote public health, safety, and comfort, including, but not limited to, weatherization, lead removal, improving household determinants of residents' health, and other programs, and the Board is committed to fostering a more integrated approach. A holistic program that coordinates or combines the delivery of multiple services to New Jersey residents with lower barriers to entry can begin to address systemic inequities. Energy affordability, which can be improved through EE, is more important than ever; New Jersey needs clean and affordable energy for everyone.

New Jersey's EE programs will continue to play a central role in rising to meet the challenge of the climate crisis while providing significant benefits to residents and businesses throughout the state and growing a clean energy workforce. In order to achieve New Jersey's robust clean energy goals, Staff recommends the framework for Triennium 2 of EE programs, as laid out herein and as will be supported by anticipated future modifications, to continue New Jersey's path to a 100% clean energy future.

BACKGROUND

The Board began approving utility demand side management ("DSM") programs for energy conservation in the 1980s and adopted DSM regulations in 1991 that (1) required electric and gas public utilities to offer conservation, EE, and load management programs, known collectively as DSM programs; (2) provided incentives to initiate and implement programs; and (3) permitted cost recovery of the programs and recovery of the fixed cost portion of lost revenues due to the programs.

On February 9, 1999, the Electric Discount and Competition Act ("EDECA") restructured the electric and gas utility industries in New Jersey by authorizing the Board to permit competition in the electric generation and gas marketplace.[34] EDECA, as amended, also directed the Board to undertake a comprehensive resource analysis ("CRA") of energy programs every four (4) years; determine the appropriate level of funding for EE, plug-in electric vehicles ("EVs") and charging infrastructure, and Class I renewable energy ("RE") programs in consultation with the New Jersey Department of Environmental Protection; and determine, as a result of the CRA, the programs to be funded by a Societal Benefits Charge ("SBC"), the utilities' level of cost recovery and performance incentives for existing and proposed programs, and whether the recovery of DSM costs may be reduced or extended.[35] EDECA charged the Board with making these determinations while taking into consideration existing market barriers and environmental benefits, with the objective of transforming markets, capturing lost opportunities, making energy services more affordable for low-income customers, and eliminating subsidies for programs that could be delivered in the marketplace without electric public utility and gas public utility customer funding.[36]

[34] L. 1999, c. 23 (N.J.S.A. 48:3-49 to -98).

[35] N.J.S.A. 48:3-60(a)(3).

[36] Ibid.

Accordingly, in 1999, the Board initiated its first CRA proceeding. In 2001, the Board issued an order that set funding levels for EE and RE programs for the years 2001 through 2003.[37] The Board directed the Utilities to administer the EE programs for one (1) year and indicated that it would retain a consultant to assist in evaluating how best to continue the administration of the programs in the following years.[38] In 2002, the Board's consultant recommended that the utilities retain EE program administration. In 2003, the Board established the New Jersey Clean Energy Council, which recommended that the Board administer EE and RE programs, and established the NJCEP, which is administered by the Board's Office of Clean Energy (now Division of Clean Energy or "DCE").

On January 13, 2008, L. 2007, c. 340 ("RGGI Act") was signed into law based on the New Jersey Legislature's findings that EE and conservation measures must be essential elements of the state's energy future and that greater reliance on EE and conservation will provide significant benefits to the citizens of New Jersey. The Legislature also found that public utility involvement and competition in the conservation and EE industries are essential to maximize efficiencies.[39]

Pursuant to Section 13 of the RGGI Act, codified at N.J.S.A. 48:3-98.1(a)(1), an electric or gas public utility may provide and invest in EE and conservation programs in its service territory on a regulated basis. Such investment in EE and conservation programs may be eligible for rate treatment approved by the Board, including a return on equity ("ROE"), or other incentives or rate mechanisms that decouple utility revenue from sales of electricity and gas.[40] Ratemaking treatment may include placing appropriate technology and program costs investments in the utility's rate base, or recovering the utility's technology and program costs through another ratemaking methodology approved by the Board.[41] An electric or gas utility seeking cost recovery for any EE and conservation programs pursuant to N.J.S.A. 48:3-98.1 must file a petition with the Board.[42]

PROCEDURAL HISTORY

Stakeholder Process

After proper notice, Staff released straw proposals and held public stakeholder meetings on April 6 and April 18, 2023 on the following topics related to the Triennium 2 EE framework: program administration and design, filing and reporting requirements, cost recovery, EE as a resource, and evaluation, measurement, and verification ("EM&V"). Staff invited stakeholders to provide written comments on these topics by April 28, 2023.

Staff reviewed and considered all stakeholder comments received throughout this process and used stakeholder input to develop and modify recommendations. Attachment B contains a comprehensive summary of general stakeholder comments and Staff's responses. Based on

[37] In re the Filings of the Comprehensive Resource Analysis of Energy Programs Pursuant to Section 12 of the Electric Discount and Energy Competition Act of 1999, BPU Docket Nos. EX99050347 et al., Order dated March 9, 2001.

[38] This proceeding and the Board's consultant's evaluation did not include Butler.

[39] N.J.S.A. 26:2C-45.

[40] N.J.S.A. 48:3-98.1(b).

[41] Ibid.

[42] Ibid.

Staff's review of recommendations from stakeholders, Staff herein proposes a framework for implementation of the second triennium of New Jersey's EE programs.

STAFF RECOMMENDATIONS

I. PROGRAM ADMINISTRATION

A. Program Years ("PYs")

Staff recommends that Triennium 2 comprise the following three (3) program years:

PY25: July 1, 2024–June 30, 2025
PY26: July 1, 2025–June 30, 2026
PY27: July 1, 2026–June 30, 2027

B. Utility-Led Programs

i. *Utility Core Programs*

Staff recommends that Utilities administer a suite of core programs that serve the following sectors and are consistently available throughout the state:

- **Residential** – Residential programs should provide comprehensive EE opportunities for existing residential buildings. At a minimum, the programs should include the following:
  - In-depth energy assessments where appropriate;
  - Incentives for whole home EE and electrification solutions, including solutions that generate deep, long-lasting, and cost-effective energy savings;
  - Efficient products, including heating, ventilation, and air conditioning ("HVAC") rebates, appliance rebates, retail products via stores and online marketplaces, and appliance recycling, with online marketplaces providing a range of point-of-sale products for customers and integration of applicable rebates; and
  - Behavioral solutions.

LMI and OBCs Residential: Residential programs should include specific opportunities for LMI and OBC customers, such as enhanced incentives and more favorable financing terms. They should continue to include an approach to income eligibility that is based on location of primary residence and self-attestation of income for customers residing in LMI census tracts, as employed in Triennium 1, with the addition of primary residence and self-attestation of income for customers residing in OBC census blocks for Triennium 2. In addition, the programs should continue to streamline the income eligibility process for customers who receive benefits from an automatic qualifying program based on income.

In addition to these incentive programs, Staff recommends that the Utilities be allowed to propose to administer the Comfort Partners program, which provides EE upgrades to low-income households at no cost to homeowners, with continued oversight by the State. Staff recommends that the Utilities develop a proposed plan to deliver Comfort Partners in coordination with the Utilities' moderate-income weatherization programs, including attention to anticipated net cost savings (i.e., anticipated cost savings associated with increased efficiencies vs. additional cost of Utility return on investment on the program) and other benefits for ratepayers, as well as attention to how the Utilities would ensure continuation of sufficient budgets for the program.

Residential programs should also seek to provide benefits to tenants by offering no-cost and low-cost actions or improvements and through strategies that may include: 1) educating building owners about the multiple benefits of EE improvements (e.g., energy savings, cost savings, additional non-energy benefits) to both tenants and building owners; and 2) providing enhanced incentives and more favorable financing terms when building owners undertake EE improvements that benefit LMI or OBC tenants.

- **Multifamily** – In addition to providing program offerings comparable to those available to residential customers where applicable (notably, in-depth energy assessments where appropriate and incentives for whole building EE and electrification solutions, including solutions that generate deep, long-lasting, and cost-effective energy savings), multifamily programs should pay particular attention to effectively serving the affordable and/or subsidized housing sectors and minimizing or eliminating as many of the barriers to EE adoption in multifamily housing as possible, including by offering specific opportunities for LMI and OBC customers, such as enhanced incentives and more favorable financing terms. As with residential programs, multifamily programs should also seek to provide benefits to tenants by offering no-cost and low-cost actions or improvements and through strategies that may include: 1) educating building owners about the multiple benefits of EE improvements; and 2) providing enhanced incentives and more favorable financing terms when building owners undertake EE improvements that benefit LMI or OBC tenants.

- **Commercial and Industrial ("C&I") –** C&I programs should provide comprehensive EE opportunities for existing C&I buildings; at a minimum, the programs should include the following:

    - In-depth energy assessments;
    - Prescriptive and custom incentives;
    - Incentives for whole building EE and electrification solutions, including solutions that generate deep, long-lasting, and cost-effective energy savings; and
    - Energy management.

  C&I programs should include specific opportunities that ensure access for small commercial customers.

  C&I programs should also provide comprehensive opportunities for existing buildings of all types that are interested in whole building EE solutions, in a way that is complementary with the State's Large Energy Users Program ("LEUP"). Furthermore, different contracting and financing requirements apply to public entities (most notably, public schools and local, county, and State government) than apply to non-public entities. Utilities should consider these differences when designing C&I programs. This includes offering public sector program pathways specifically designed to meet the unique needs of and requirements associated with public sector customers. Utilities should work with Staff to address any barriers to participation by public sector customers. In particular, Utilities should be mindful of the requirements of the various public contracting laws with which public entities must comply. These laws specify various requirements for public contracts, including but not limited to bidding of contracts, publicly disclosed pricing sheets, public works contractor registration, prevailing wage, prohibitions on the use of debarred contractors, New Jersey Division of Property Management Construction ("DPMC") qualification and/or certification, and equal employment opportunity / affirmative action ("EEO/AA"). Prior to marketing their programs to any public entities, Utilities are responsible for ensuring that these programs are structured to provide for public entity compliance with their unique legal requirements.

ii. *Additional Utility Initiatives (RESERVED)*

iii. Consistency in Program Elements and Design Standards

Staff recommends that the Utilities file individual program proposals, but collaborate to consistently implement the Utility core programs. Coordinated program elements for Utility core programs should include the following:

Contractors/Trade Allies:

- Contractor engagement platforms;
- Processes to qualify and register trade allies, including a streamlined process to the greatest extent possible so as to avoid contractors having to undertake duplicative activity with each individual Utility;
- Processes to verify DPMC qualification/certification of contractor based on type of service provided;
- Processes to engage program implementation contractors, with procurement protocols including policies and practices developed in consultation with the Equity Working Group and Workforce Development Working Group that encourage supplier diversity (including contractors and subcontractors) and contractor coaching/mentoring of diverse business enterprises; and
- Training requirements;
- Clear guidelines for trade allies and program implementation contractors regarding compliance with prevailing wage law and the Public Works Contractor Registration Act for applicable projects, as well as any additional requirements applicable to public entities (e.g., public schools and local, county, and State government);
- Common forms for use by contractors; and
- Incentive payment processes and timeframes.

In addition, Utilities should confer with the Equity Working Group to continue to develop and implement procurement protocols for all applicable programs that encourage supplier diversity (including contractors and subcontractors) and with the Workforce Development Working Group regarding contractor coaching/mentoring of diverse business enterprises.

Customers:

- Processes to engage with customers, including a streamlined process to the greatest extent possible so that customers have a clear understanding of program offerings and are able to efficiently and effectively participate in the programs;
- Customer and property eligibility requirements and processes, including alternative/automatic eligibility methods for LMI customers (e.g., based on census tracts, environmental justice communities, Urban Enterprise Zones, etc.);
- Common data elements on forms for use by customers; and
- Incentive payment processes and timeframes.

Other Elements and Design Standards

- Eligible measures;
- Incentive ranges;
- Data platforms and database sharing among program administrators, where appropriate; and
- Quality control standards and remediation policies.

Additionally, Staff proposes requiring the following common elements for both core programs and additional initiatives:

- Easy customer access to current and historic energy usage data, with reasonable protections from inappropriate release, with the data remaining the property of customers; and
- On-bill and/or third-party, including locally-based, financing options for qualified EE investments in Utility programs.

iv. ***Budgeting Based on Commitments***

Staff recommends that, consistent with existing practices and prior Board guidance regarding DCE and Utility programs, each Utility's portfolio plan budget should include investment amounts that will be committed to, and spent during, each three-year program cycle, as well as amounts that will be committed to during the three-year cycle but that may be spent subsequent to the cycle in which they were committed.

v. ***Joint Utility Coordination***

In areas where gas and electric service territories overlap, in addition to establishing programs that include agreed-upon program design standards, as described above, Staff recommends that the Utilities design a program structure that results in coordinated, consistent delivery of programs among all of the Utilities and allocates costs and energy savings appropriately based on the fuel type(s) treated by EE measures. The Utilities shall ensure that customers do not face confusion as a result of overlapping territories and can access both electric and gas measures simultaneously, where appropriate. As part of this approach, Staff recommends that the Utilities continue to jointly engage a Statewide Coordinator system to facilitate the exchange of information and coordinate implementation of programs in overlapping Utility territories by Lead and Partner Utilities.[43]

Staff also recommends that Utilities continue to jointly plan and coordinate budgets in overlapping Utility territories, with support from the Statewide Coordinator system as appropriate, as well as to work cooperatively to identify and address budget constraints between the Utilities through the Joint Budget Allocation Committee (which has been established to monitor and manage program budget coordination among the Utilities) and as set forth in the Utilities' bilateral Memoranda of Agreement.

vi. *Flexibility*

Staff recommends that Utilities be permitted to make certain adjustments to Utility-led programs according to the conditions below. Staff recommends that the Utilities collaborate and coordinate on proposed changes and that a Utility notify Staff, Rate Counsel, and any parties to the Utility's filing of changes to programs, budgets, or incentive ranges as defined below. Furthermore, Staff recommends adding a requirement that no shift within or between sectors can result in a program being terminated without Board approval.

- Sectors shall be defined as:
  - Residential
  - Commercial & Industrial
  - Multifamily
  - Other
- The addition of new programs, discontinuation of existing programs, or major modifications that significantly alter the nature of existing program structures as approved will require Board approval.[44]
- Budget Adjustments
  - Within any 365-day period of time, each Utility can shift budget(s) between individual programs within the same sector up to and including 25% of the total triennium budget with Staff and Rate Counsel notification; greater than 25% and up to 50% with Staff approval; and greater than 50% with Board approval.

[43] The utility that serves as the primary point of contact for customers, contractors, and trade allies for a project is considered to be the lead utility ("Lead Utility") for that project. The Lead Utility follows the project through to completion, pays the project incentive and financing/on-bill repayment, if relevant, and then works with the partner utility ("Partner Utility") to transfer the energy savings for their fuel and the cost of the investment for their share of the project.

[44] In an instance where a Utility or Utilities anticipate that a program is at risk of being shut down due to the budget being exhausted, the Utilities will provide Staff and Rate Counsel with notification at least 30 days before the program is shut down so that the parties may work together to avoid the shut down. However, in the event of exigent circumstances, which may include instances where sudden market activity makes 30 days' advance notice impractical, the Utilities will provide notice to Staff and Rate Counsel as soon as possible.

  - Within any 365-day period of time, each Utility can shift budget(s) out of a sector up to and including 10% of the total triennium budget with Staff and Rate Counsel notification; greater than 10% and up to 20% with Staff approval; and greater than 20% with Board approval.

  - Requests for budget adjustments within the three-year program filing necessitating Staff approval shall be responded to within 30 days after receipt of the notification by Staff and Rate Counsel. In addition, Rate Counsel may object within 30 days after receipt of the notification, which will also trigger Staff's review and decision within 30 days of Rate Counsel's objection. Otherwise, if there is no response from Rate Counsel or Staff within 30 days, those requests will be automatically granted.

- Incentive Adjustments

  - Core programs: As mentioned previously, the Utilities shall propose incentive ranges as common elements for core programs within which they can adjust incentives as needed; any adjustments outside the established range requires Staff approval.

  - Additional Utility-led initiatives: The Utilities shall propose incentive ranges for additional Utility-led initiatives within which they can adjust incentives as needed; any adjustments outside the established range requires Staff approval.

  - Requests for incentive adjustments necessitating Staff approval shall be responded to within 15 days. In addition, Rate Counsel may object within 15 days, which will also trigger Staff's review and decision within 15 days of Rate Counsel's objection. Otherwise, if there is no response from Rate Counsel or Staff within 15 days, those requests will be automatically granted.

C. State-Led Programs and Initiatives

Staff recommends that the State administer a series of complementary programs serving the following market sectors or addressing the following areas:

- New construction for all building types through a program that is redesigned to increase EE and environmental performance and transform the new construction market into one in which most new buildings in the state will be "net zero energy."

- Commercial and Industrial – existing large energy users, not including hospitals, pursuing comprehensive projects via the LEUP;

- Combined heat and power ("CHP") / fuel cell projects;

- State and Local Government – Local Government Energy Audits ("LGEA"), Energy Savings Improvement Program ("ESIP"), and State Facilities Initiative ("SFI"); and

- Quantification of energy savings from building energy codes.

D. Workforce Development

Staff recommends that that Utilities work in collaboration with the Workforce Development Working Group to support the continued development and implementation of workforce development and job training partnerships and pipelines (e.g., with vocational institutions, community colleges, community-based organizations, non-profits, etc.) that recruit, train, and employ residents for EE jobs, including local, underrepresented, and disadvantaged workers.

To this end, Staff recommends a complementary approach between State-funded and Utility-funded initiatives, as follows:

State-funded workforce development initiatives would include provision of employment and training services for individuals interested in clean energy careers through competitive grants to community-based organizations from the New Jersey Department of Labor in partnership with Utility companies. These grants will recruit eligible participants from New Jersey's OBCs to receive core employment and training services, such as workforce readiness and financial literacy instruction, wrap-around supportive services, job coaching, and job placement services to facilitate entrance into the clean energy workforce.

These State-funded grants will also provide opportunities for intensive employment and training services, such as occupation skills trainings resulting in industry-recognized credentials, and needs-based on-the-job training ("OJT") placements with employers intended to provide a bridge for participants into sustainable, unsubsidized employment.

Staff also recommends that the Workforce Development Working Group explore opportunities to provide coaching for small businesses.

Utility-funded initiatives would include subsidized or no-cost training programs for workers to gain credentials, including certifications, that are required for employment in EE and decarbonization jobs. The Utilities should develop these training programs in consultation with the EE Workforce Development Working Group (see Section X), including with consideration of flexible and online training opportunities.

E. Coordination Between Utility-Led and State-Led Programs

When Utility-led and State-led programs overlap in their service to the same customers, Staff recommends that the administrators of these programs coordinate and adjust their respective program rules, as needed, to simplify the process for customers. This coordination may apply to the development of complementary, rather than duplicative, program requirements and offerings.

ESIP:

Specifically regarding ESIP projects, Staff recommends that Utility programs assign a designated staff member to work in collaboration with the BPU ESIP Coordinator on ESIP-designated projects. The ESIP Coordinator will notify the staff member when they are aware of an ESIP project. The Utility shall provide written confirmation to the ESIP Coordinator of the Utility's agreement on the incentives that are expected to be paid out to the project.

Where Utility program design overlaps with ESIP law, the law will control in designing implementation, including but not limited to the choices made around energy assessments and energy savings plan design. ESIP projects will be eligible to bid demand response for energy conservation measures ("ECMs") that are not being incentivized by the Utility. Furthermore, the ESIP law allows for two (2) types of financing: bonds or lease purchase agreement. Utilities should plan to offer incentives that comport with these two (2) options or structure the incentive as a rebate.

The ESIP law gives BPU the ability to withhold EE incentives from an ESIP project. As such and in an effort to avoid this outcome, the ESIP Coordinator will work in conjunction with the Utility administrator as the project progresses. Periodic reporting may be required, including a true-up of incentives at completion of construction. The ESIP program will designate ECMs as either Utility-incentivized or non-Utility incentivized. Non-Utility incentivized ECMs will count towards the State's goal and be eligible for demand response.

II. PROGRAM FUNDING

Staff recommends that Utility program administration costs be expensed annually, whereas program investments should be amortized over time, as explained in more detail in the "IV. Filing Requirements: C. Utility Annual Compliance and Cost Recovery Petitions" and "V. Cost Recovery" sections below. Electric Utilities must offer electric savings associated with EE investment into the capacity markets operated by PJM, as explained in more detail in the "VI. Energy Efficiency as a Resource" section below.

State-administered programs will be implemented using SBC funds, which are collected by Utilities through their rates. Staff also proposes that the State and Utilities explore and pursue additional State and federal funding that supports and complements New Jersey's existing EE programs and defrays burdens on ratepayers. In addition, Staff plans to work with Utility and State program administrators and Rate Counsel to determine how to most efficiently and effectively leverage additional funding from the U.S. Department of Energy, including Inflation Reduction Act efficiency and electrification rebates, to maximize the benefits of existing programs. Staff will propose plans for how to leverage any additional funding, which may include adjustments to Utility and State program design and delivery as needed, for feedback from public stakeholders.

III. GOALS, TARGETS, PERFORMANCE INCENTIVE MECHANISM (RESERVED)

IV. FILING REQUIREMENTS

A. Utility Program Filings

As noted earlier, the CEA states that each electric and gas public Utility shall establish EE and PDR programs to be approved by the Board no later than 30 days prior to the start of the energy year, which begins on June 1 every year.[45] The programs adopted by each Utility shall comply with the quantitative performance indicators ("QPIs") adopted by the Board.[46]

Staff recommends that the Board direct the Utilities to submit three-year program filings compliant with minimum filing requirements ("MFRs") by October 2, 2023 for approval by the Board by May 1, 2024 and implementation beginning July 1, 2024. Per the Board's Order issued May 12, 2008 establishing MFRs for EE, renewable energy, and conservation programs, the following applies:[47]

> Pursuant to N.J.S.A. 48:3-98.1 (c), electric public utilities and gas public utilities shall be allowed to invest in and offer energy efficiency and/or conservation programs, to invest in Class I renewable energy resources, and to offer Class I renewable energy programs in their respective service territories on a regulated basis provided that they file a petition and obtain Board approval for each such program and for any program cost recovery;
>
> At least 30 days prior to the filing of a petition pursuant to the Act, the petitioning electric or gas public utility shall meet with Board Staff and Rate Counsel to discuss the nature of the program and program cost recovery mechanism to be proposed in the forthcoming petition and the Appendix A minimum filing requirements to be submitted;
>
> With any petition filed pursuant to the Act and this Order, an electric or gas public utility shall submit such information as is required for the petition by the minimum filing requirements set forth in Appendix A hereto, as may be modified by Board Staff in accordance with this Order; and
>
> Board Staff shall, within 30 days after the filing of a petition pursuant to the Act, (i) determine whether the petition is administratively complete, and (ii) advise the petitioner in writing that the petition is administratively complete or that the petition is not administratively complete, and set forth the deficiencies, and the items required to remedy the deficiencies. If the petition is deemed administratively complete by Board Staff, the 180 day time period under N.J.S.A. 48:3-98.1 for issuance of a written order will commence at the time of the petition's filing. If Board Staff has notified the utility that the petition is not administratively complete, the 180 day period will not commence until the deficiencies are corrected and the

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[45] N.J.S.A. 48:3-87.9(d)(1).

[46] Ibid.

[47] In re Electric Public Utilities and Gas Public Utilities Offering Energy Efficiency and Conservation Programs, Investing in Class I Renewable Energy Resources, and Offering Class I Renewable Energy Programs in Their Respective Service Territories on a Regulated Basis Pursuant to N.J.S.A. 48:3-98.1, BPU Docket No. EO08030164, Order dated May 12, 2008.

filing is deemed administratively complete by Board Staff. In that event, the 180 day period will commence on the date that the petition is deemed administratively complete, that is, on the last filing date of the remediation of all deficiencies.

Staff recommends that the Board direct the Utilities to jointly develop a consistent organizational structure with common elements in their filings, to the greatest extent practicable. This will help to facilitate and expedite review by the Board and parties to each of the seven (7) Utility filings, toward the end of program implementation beginning July 1, 2024. Staff will also endeavor to provide any notice of administrative deficiency as soon as possible so that a Utility can promptly remedy any deficiencies.

Staff recommends that Butler again work collaboratively Rate Counsel and the investor-owned electric and gas utilities, as applicable, to develop a proposal for Butler's EE and PDR programs and for Butler to file a petition at the same time as the investor-owned utilities.

Utilities will also file annual compliance and cost recovery petitions, as described below.

Minimum Filing Requirements

The CEA further states that each electric and gas public Utility shall file with the Board implementation and reporting plans, as well as EM&V strategies, to determine the energy usage and PDR achieved by approved EE and PDR programs.[48] The filings shall include details of expenditures made by the Utility and the resulting reduction in energy usage and peak demand. The Board shall determine the appropriate level of reasonable and prudent costs for each program as part of its review of the Utilities' cost recovery filings, as further described in Section IV(C) below.

Pursuant to these requirements, Staff recommends updated and revised MFRs, as provided in Attachment A.

The current MFRs for petitions under N.J.S.A. 48:3-98.1, which apply to EE and PDR program petitions and which were approved in the June 10, 2020 Order, comprise requirements for program descriptions, implementation, marketing, quality assurance, QPIs, EM&V, and reporting plans.

Recommended revisions to the MFRs for petitions under N.J.S.A. 48:3-98.1 and N.J.S.A. 48:3-87.9 reallocate required information between the sections describing programs and portfolios; require consistent use of program cost categories; provide for a separate accounting of workforce development and job training costs, health and safety costs, and costs of outreach to community-based organizations; and include updates consistent with current New Jersey evaluation guidance documents and standards.

B. <u>State Program Filings</u>

Staff recommends that the Board direct Staff to manage the development and submission of NJCEP filings, or program plans, during Triennium 2 to align with the delivery of Utility-administered EE programs. More specifically, Staff recommends that the Board direct

[48] N.J.S.A. 48:3-87.9(d)(3).

Staff to work with NJCEP's program administrator to develop three-year NJCEP program plans in coordination with Utility program administrators and stakeholders as appropriate, file those plans with the Board every three (3) years as part of the NJCEP annual budget process, and file updates to each three-year plan on an annual basis to confirm each year's program budget, subject to allocations based on the CRA process.[49] These program plans will be based on the State's performance targets, as established by the Board.

C. Utility Annual Compliance Petitions

Pursuant to N.J.S.A. 48:3-87.9(e)(1), each Utility shall file an annual petition with the Board to demonstrate compliance with its approved EE and PDR program plans, to demonstrate compliance with the targets established pursuant to the QPIs based on its annual program report. Staff recommends that each Utility submit its annual compliance filing no later than 150 days following the end of each program year. Staff recommends that the Board provide Staff with the flexibility to adjust the filing due date when necessary.

V. COST RECOVERY

N.J.S.A. 87.9(e)(1) provides that each Utility shall file "to recover on a full and current basis through a surcharge all reasonable and prudent costs incurred" as a result of EE and PDR programs, "including but not limited to recovery of and on capital investment, and the revenue impact of sales losses resulting from implementation" of the programs, which shall be determined by the Board pursuant to N.J.S.A. 48:3-98.1.

N.J.S.A. 48:3-98.1(b) provides that, in determining the recovery by Utilities of program costs, the Board "may take into account the potential for job creation from such programs, the effect on competition for such programs, existing market barriers, environmental benefits, and the availability of such programs in the marketplace." This statutory section also provides that ratemaking treatment may include placing appropriate technology and program cost investments in the Utility's rate base or recovering the Utility's technology and program costs through another ratemaking methodology approved by the Board, including, but not limited to, the SBC established pursuant to N.J.S.A. 48:3-60. Finally, this statutory section provides that all Utility investment in EE and conservation programs may be eligible for rate treatment approved by the Board, including an ROE, or other incentives or rate mechanisms that decouple Utility revenue from sales of electricity and gas.

Generally, Staff has been guided by the concept that there are three (3) crucial regulatory tools needed to align the Utility business model with EE and the aggressive energy saving targets set forth in the CEA: 1) recovery of program costs; 2) recovery of potential lost revenues due to efficiency programs; and 3) earnings consequences for efficiency investments through performance incentives and penalties. Staff's recommended cost recovery framework below addresses these first two (2) components.

A. Program Costs

Staff recommends that each Utility shall annually file on a full and current basis, through

[49] NJCEP compliance filings would be submitted for public comment by the second quarter of each applicable year for approval by the Board prior to the beginning of each applicable fiscal year.

a surcharge, all reasonable and prudent costs incurred as a result of EE and PDR programs, including but not limited to recovery of and on capital investment.

B. Investment Treatment

i. Amortization

Staff recommends that most program investments be amortized over a time period that aligns with the weighted average useful life of each Utility's proposed portfolio but that this period should not exceed 10 years. However, Staff also recommends that the parties to each Utility filing and stakeholders be allowed to explore shorter amortization periods to align with the State's energy policy goals, as set forth in the EMP and Executive Orders 316 and 317.

ii. Rate Caps

In order to encourage reaching EE goals, Staff recommends that the Board continue the practice of not establishing an absolute cap on customer distribution rates or bills associated with EE and PDR investments. Instead, Staff recommends that the Board ensure financial discipline by requiring Utilities to continually monitor investments and report on program costs, comply with cost-benefit requirements, and otherwise demonstrate that the investments are prudent. Additionally, Staff recommends that rate impacts be closely monitored through the annual petitions for cost recovery and that the Board evaluate the need for a cap on rates or customer bill impacts during the triennial review.

iii. Return on Equity

Staff recommends that the carrying costs for program investments use the capital structure established in each Utility's most recent base rate case, incorporating both the cost of debt and the ROE. Staff recommends no basis point reduction on the ROE in order to recognize EE's importance compared to traditional Utility investments.

C. Lost Revenue Treatment

The CEA calls for Utilities to file for the revenue impact of sales losses resulting from implementation of EE and PDR programs. Staff recommends that Utilities continue to be able to file for, and recover potential lost revenues, in the amount that they can demonstrate were attributable to Utility-run EE and PDR programs.

Staff recommends that Utilities be able to propose either a Lost Revenue Adjustment Mechanism ("LRAM") or a Conservation Incentive Program ("CIP").

Staff recommends that Utilities continue to be required to file a base rate case no later than five (5) years after the commencement of an approved EE program in order to update usage projections and reset lost revenues. Staff recommends that the five-year requirement may be satisfied sooner if the Utility files a base rate case due to a prior obligation, such as one from an Infrastructure Investment Program.

Staff also continues to recommends an earnings test through which actual ROE shall be determined based on the actual net income of the Utility for the most recent 12-month period divided by the average of the beginning and ending common equity balances for the corresponding period. For any EE portfolio approved by the Board, if the calculated ROE exceeds the allowed ROE from the Utility's last base rate case by 50 basis points or more, recovery of lost revenues through a CIP or LRAM shall not be allowed for the applicable filing period.

VI. ENERGY EFFICIENCY AS A RESOURCE

Staff acknowledges that participation in the PJM FCM benefits New Jersey customers by obtaining revenues that offset EE/PDR program costs. Therefore, Staff recommends that the electric Utilities continue to offer into the PJM FCM-eligible EE measures and their associated peak reduction values ("EE resources") from projects that they have led.[50] The EE peak reduction values should be calculated and evaluated consistent with PJM's governing Manuals 18 and 18B. Staff recommends that the timing and execution of FCM offers by the electric Utilities be as follows:

Staff recommends that the Board require the electric Utilities to offer EE resources for program years within the Triennium 2 program cycle into the eligible FCM Base Residual Auctions ("BRAs"). Sell offers and/or buy bids into the Incremental Auctions ("IAs") or into secondary markets to true up market positions originally offered in the BRA shall be allowed as permitted under PJM market rules.

Staff also recommends that, in order to increase the revenues returned to customers as early as possible, the Board permit the electric Utilities to offer EE resources for core programs from program years that are beyond the currently approved three-year budget for the EE/PDR programs, beginning with the 2026/2027 BRA. The Utilities will not have approved EE/PDR program budgets at the time of those auctions, so they should exercise their judgment on the estimated offers for resources and peak reduction values for core programs that may be installed in a program year. Estimates should be conservative to avoid over-commitments and based only on projected demand savings associated with "core" programs, as identified by the Board in the previous triennium.

The Utilities will use the IAs, or the secondary market, to true up their market positions originally offered in the BRA as needed once the Utilities gain more certainty on their available resources. If Utilities incur any PJM penalties or losses, Staff recommends that the Utilities petition to recover such losses or penalties incurred in a subsequent cost recovery filing, providing support that the Utilities exercised prudence in their FCM offers and acted reasonably with respect to their positions in the IAs or in the secondary market.

Staff recommends that the electric Utilities submit confidential reports to Staff and Rate Counsel after every auction providing the offered and cleared EE resource megawatt values and clearing prices.

If a Utility determines that its participation in the PJM FCM will not cost-effective for New Jersey customers – in other words, that the Utility anticipates that the costs required to obtain the revenues will exceed the revenues obtained, Staff recommends that the Board allow the Utility to seek a waiver of the requirement.

[50] PSE&G will offer measures from projects it has led in its gas-only service territory as well.

VII. EVALUATION, MEASUREMENT, AND VERIFICATION

The CEA directs the Board to establish the process for evaluating, measuring, and verifying energy usage reductions and peak demand reductions by the public utilities.[51]

A. EM&V Administrative Structure and Working Group

In the June 10, 2020 Order, the Board called for establishment of an EM&V Working Group ("EM&V WG"). Facilitated by the Statewide Evaluator ("SWE"), the EM&V WG brings together Staff, Rate Counsel, and the Utilities – with technical evaluation contractors, program implementation contractors, and representatives from the other EE working groups as appropriate to provide guidance and input on relevant issues – to collaborate to develop a standard, transparent, and replicable approach for evaluating, measuring, and verifying the results of EE and PDR programs implemented pursuant to the CEA. As part of this standard statewide approach, the State and Utilities are held to the same accountability standards through collaboratively developed plans, schedules, procedures, guidelines, and requirements for program administrators. The EM&V WG shares associated data, as appropriate, considers best practices from other jurisdictions, and facilitates the necessary stakeholder processes related to the State's EM&V policies. The EM&V WG is highly deliberative and advisory regarding key EM&V plans and recommendations, and provides recommendations to Staff, with the Board retaining ultimate decision-making authority.

The EM&V WG establishes committees as needed on targeted issues. The current committees are the TRM Committee, NJCT Committee, and Guidelines Committee, with each comprising various members of the EM&V WG.

The SWE has led the development of a recommended "New Jersey Energy Efficiency Triennium 2 Evaluation Framework" that describes roles and responsibilities of the entities participating in the EM&V of Triennium 2 programs; and outlines the activities, products, and processes that guide the EM&V of the programs.[52]

B. Evaluation Studies

In the June 10, 2020 Order, the Board directed Staff to ensure that the EM&V WG developed and recommended a timeline for EM&V studies for each triennium. As described in more detail in the recommended Evaluation Framework referenced above, the SWE has developed an "Evaluation Studies List and Plan for Triennium 2."[53] The Evaluation Studies List will be updated annually based on changing priorities and new study and topic needs and in accordance with the Evaluation Framework. Details

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[51] N.J.S.A. 48:3-87.9(f)(1).

[52] The "New Jersey Energy Efficiency Triennium 2 Evaluation Framework" is available on the "Program Evaluations, Market Analysis and TRMs" page in the "Evaluation Plans" section at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an.

[53] The "Evaluation Studies List and Plan for Triennium 2" is available on the "Program Evaluations, Market Analysis and TRMs" page in the "Evaluation Plans" section at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an.

contained in the Evaluation Studies List and Plan may be updated more frequently based on new information and continuing discussions with Staff and the EM&V WG.

C. Goal Setting Process

Additionally, as described in more detail in the Evaluation Framework, certain studies on the Evaluation Studies List support the development of new Utility and State goals for each triennium.

D. Evaluating Energy Savings

The CEA calls for the Board to require each electric and gas public utility to reduce the use of electricity or natural gas, as appropriate, within its territory by its customers below what would have otherwise been used.[54] Additionally, N.J.S.A. 87.9(c) provides that a public utility may apply all energy savings attributable to programs available to its customers, including demand side management programs, other measures implemented by the public utility, non-utility programs, including those available under EE programs in existence on the date of enactment of the CEA, building codes, and other efficiency standards in effect, to achieve the targets.

i. *Technical Reference Manual ("TRM")*

The TRM is the compendium of algorithms and parameter assumptions that is used to calculate resource savings – including electricity, natural gas, and other resource savings – and energy and capacity and peak demand savings for technologies and measures supported by the BPU and Utilities. It is updated as needed to reflect the addition of new measures, modifications to existing measures, changes to codes and standards, and the results of evaluation studies. The TRM should be used consistently statewide to assess program impacts and calculate energy and peak demand savings consistent with BPU guidance. In particular, the TRM is used to estimate energy savings in EE program filings, evaluate compliance in meeting the energy savings goals in the CEA, and determine achievement of performance targets for the triennium.

In its October 12, 2022 Order updating and revising the Triennium 1 Framework, the Board approved Staff's recommendation for the SWE, EM&V WG, and TRM Committee to support the development of a comprehensive update of the TRM, including input and feedback through a public stakeholder process, for the Board's consideration ahead of the commencement of Triennium 2 EE programs.[55]

As described in the Evaluation Framework, Staff recommends that a Triennial TRM be established prior to the start of each triennium and that an Annual TRM Update be completed in the intervening years. The TRM Committee has developed the

[54] N.J.S.A. 48:3-87.9(a).

[55] In re the Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket Nos. QO19010040 & QO20100684, Order dated October 12, 2022.

recommended Triennial TRM for use in Utility and State filings and reports ("New Jersey 2023 Triennial Technical Reference Manual").[56]

ii. *Net-to-Gross ("NTG") Factors*

NTG ratios estimate the savings attributable to specific programs or measures, not including free riders or spillover effects.

For Triennium 1, based on the CEA's call for all attributable energy savings to be calculated, as well as Staff's recommendation that using net savings to measure and evaluate energy savings is appropriate, the Board adopted Staff's recommendation that, in (1) calculating energy reductions resulting from EE and PDR programs and (2) applying other permissible savings, State and utility program administrators should report energy savings in both gross and net savings, and use net savings for all aspects of program review, including compliance and cost-effectiveness testing.

While the Board accepted a NTG value of 1.0 for all programs in Triennium 1, the Board also adopted Staff's recommendation to establish accurate NTG ratios to ensure that program administrators are incented to design programs that maximize savings attributable to those programs and account for free ridership and spillover effects. Based on Board guidance, Staff and the EM&V WG coordinated a study for recommended NTG ratios to calculate net savings and inform planning for Triennium 2 programs ("NTG study"). This NTG study, "New Jersey Recommended Net-to-Gross Ratios Overall Report," submitted by NMR Group, Inc., is available on the NJCEP website.[57]

For Triennium 2, after review and consideration of all of the public stakeholder comments on the TRM and NTG (as summarized and responded to in Attachments D and E, respectively), Staff recommends the Triennium 2 TRM, as provided in Attachment C.

The recommended Triennium 2 TRM includes an appendix for NTG factors based on the NTG study. The recommended Triennium 2 TRM also includes appendices on realization rates, in-service rates, and other topics.

E. <u>Benefit-Cost Analyses ("BCAs") / Cost-Effectiveness Testing</u>

BCAs of EE programs calculate the benefits (including avoided energy costs and various non-energy benefits) and costs (including incremental measure costs and program administration costs) of the programs.

[56] The Triennial TRM is available on the "Program Evaluations, Market Analysis and TRMs" page in the "Technical Reference Manuals" section at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an.

[57] The NTG study is available on the "Program Evaluations, Market Analysis and TRMs" page in the "Technical Reference Manuals" section at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an.

The CEA at N.J.S.A. 48:3-87.9(d)(2) states:

> The energy efficiency programs and peak demand reduction programs shall have a benefit-to-cost ratio greater than or equal to 1.0 at the portfolio level, considering both economic and environmental factors, and shall be subject to review during the stakeholder process established by the board pursuant to subsection f. of this section. The methodology, assumptions, and data used to perform the benefit-to-cost analysis shall be based upon publicly available sources and shall be subject to stakeholder review and comment. A program may have a benefit-to-cost ratio of less than 1.0 but may be appropriate to include within the portfolio if implementation of the program is in the public interest, including, but not limited to, benefitting low-income customers or promoting emerging energy efficiency technologies.

i. NJCT

Staff notes the CEA's directive for EE and PDR programs to have a benefit-to-cost ratio greater than or equal to 1.0 at the portfolio level and the CEA's requirement that the test consider both economic and environmental factors.

Prior to Triennium 1, the BPU based its BCA of EE programs on the California Standard Practice Manual ("CSPM"), which defines five (5) main cost tests for the BCA to align with the various perspectives of key stakeholders.[58]

For Triennium 1, the Board adopted a primary cost-effectiveness test for the evaluation of EE and PDR programs, which is called the interim New Jersey Cost Test. The Board also required program planners and administrators to continue to report the results of all five (5) CSPM tests for information purposes during Triennium 1. When proposing the interim NJCT, Staff recognized that it might not include the full range of possible non-energy impact benefits and costs that could be included in a primary test.

The Board directed Staff to ensure that the EM&V WG evaluate relevant non-energy benefits and costs for inclusion in the NJCT, recommend third-party studies to further evaluate and quantify non-energy impacts as needed, and recommend on an ongoing basis additional non-energy benefits and costs to consider including in future updates to the NJCT.

Specifically regarding avoided costs, the Board directed Staff to ensure that the EM&V WG develop and recommend an approach to estimating avoided costs on a statewide basis, using Utility-specific inputs where appropriate, for consideration by Staff.

For Triennium 2 and beyond, as described in the proposed Evaluation Framework, Staff agrees with the SWE's recommendation that the NJCT be updated prior to each triennium through stakeholder input and Board approval.

During Triennium 1, the NJCT Committee evaluated and discussed potential priority updates to the interim NJCT. For Triennium 2, the SWE provided a memo outlining SWE's recommended updates to the NJCT, including 22 recommendations for

[58] These cost tests are the Participant Cost Test, Program Administrator Cost Test or Utility Test, Ratepayer Impact Measure Test, Total Resource Cost Test, and Societal Cost Test.

updates to the design, content, methodologies, and sources used to calculate values contained in the NJCT. As part of this summary document, SWE recommended a review of Utility submissions of avoided cost values and their derivation to illustrate the values associated with the methodologies contained in SWE's NJCT recommendations. The Utilities provided a spreadsheet of "NJ Sample Avoided Costs – April 2023" toward this end.

Additionally, during Triennium 1, SWE provided a memo entitled "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs): Analysis of Alternatives for Updates for the State of New Jersey."[59]

Further, during Triennium 1, the EM&V WG, through the Rutgers Center for Green Building ("RCGB"), coordinated a study by DNV Energy Insights USA Inc. about incremental measure costs ("IMCs"), which represent the difference in price to install EE equipment compared to baseline equipment. The IMC study resulted in recommended IMCs for all measures in the proposed Triennial TRM and prioritized measures for future primary research. As noted in the "NJCT Recommendations Summary," the NJCT Committee recommended incorporation of the IMC values into the NJCT. The recommended IMC values and an accompanying memo are available on the NJCEP website.[60]

For Triennium 2, after review and consideration of the public stakeholder comments (as summarized and responded to by Staff in Attachments G and H), Staff recommends the Triennium 2 NJCT, as provided in Attachment F. This Triennium 2 NJCT includes some but not all of the changes included in Staff's EM&V straw proposal, and also incorporates many but not all of the changes suggested by stakeholders. Staff believes that this Triennium 2 NJCT strikes a balanced and reasonable approach to accounting for the costs and benefits of EE programs and notes that the EM&V WG and NJCT Committee will continue to identify, research, and evaluate future changes to the NJCT.

VIII. REPORTING REQUIREMENTS

A. Utility Reports

Staff recommends that the Utilities submit public reports to the Board according to the reporting framework outlined below. Staff recommends that Staff issue standard report formats in collaboration with the Utilities through the EM&V WG. All public reports will be available to any interested party on the NJCEP website.[61] Staff further recommends that

[59] The NEBs memo is available on the "Program Evaluations, Market Analysis and TRMs" page in the "Cost Effectiveness Analysis & Avoided Cost" section at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an.

[60] The IMC values and memo are available on the "Program Evaluations, Market Analysis and TRMs" page in the "Cost Effectiveness Analysis & Avoided Cost" section at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an.

[61] These progress reports will be available on the "Financial & Energy Savings Reports" page at https://www.njcleanenergy.com/main/public-reports-and-library/financial-reports/clean-energy-program-financial-reports.

the Board provide Staff with the flexibility to adjust the reporting due dates when necessary.

i. ***Quarterly Progress Reports***

No later than 60 days following the end of each quarter, the Utility shall submit a user-friendly, public report in spreadsheet format on the following program-level parameters compared to program projections and goals:

- Annual, lifetime, and peak energy savings
- Number of program participants: total, low- to moderate-income, OBC, and small commercial
- Program expenditures

ii. ***Annual Progress Reports***

No later than 150 days following the end of each program year, the Utility shall submit a user-friendly, public report, with accompanying spreadsheet(s), that includes the same program-level data as those that are included in the quarterly reports. The annual report shall show overall progress and performance of programs that are seasonal or cyclical in nature. In addition, the annual report shall include the following:

- A progress/performance narrative that provides an overview of program performance
- A narrative about customer participation and incentives paid
- The Utility program administrator's initial and final benefit-cost test results for the programs and portfolio (as defined in Section V of the MFRs)
- Assessment of the portfolio's compliance with the targets established pursuant to the QPIs (addressed in Section VII of the MFRs)
- Any proposed changes or additions for the next year or cycle

If requested, the Utilities will provide end use, measure level, and/or other program data within 30 days to Staff.

iii. ***Triennial Progress Reports***

No later than 150 days following the end of the last year of the triennium, the Utility shall submit a public report that takes the place of the annual report for that year. This report will be identical to the annual report but will also review the portfolio's data and assess the portfolio's success over the three-year program cycle.

B. <u>State Reports</u>

Staff recommends that State program administrators submit public reports consistent with the Utility reporting framework, as applicable to State programs.

C. <u>Statewide Compilation Reports</u>

Staff recommends that the State aggregate the data from Utility and State programs and produce semi-annual and annual public reports on the performance and progress of all

EE and PDR programs and include GHG emissions reductions. Semi-annual compilation reports should aggregate the content provided in the quarterly reports, and annual compilation reports should aggregate the content provided in the annual reports.

IX. TRIENNIAL REVIEW

Pursuant to the CEA at N.J.S.A. 48:3-87.9(c), the Board shall review each QPI every three (3) years.

Staff recommends that, every three (3) years, ahead of each Utility filing cycle, Staff should continue to undertake a triennial review process to review and provide recommendations on the following for the subsequent triennium:

- Targets for overall Utility territory-specific annual energy use reduction of at least 2% for electricity and at least 0.75% for natural gas that will apply until such time as all cost-effective EE is achieved in the territory, pursuant to N.J.S.A. 48:3-87.9(a) (for *each Utility and each energy source)*
    - Targets for State program annual energy savings *(for each Utility territory and each energy source)*
    - Targets for Utility program annual energy savings *(for each Utility territory and each energy source)*
- QPIs *(consistent for all Utilities and the State)*
- Weighting structure of QPIs *(consistent for all Utilities)*
- Performance incentives and penalties mechanism
- Cost recovery mechanisms
- Program administration and design

X. STAKEHOLDER GROUPS

Utility Working Group ("UWG")

Staff recommends utilizing the ongoing UWG (which is comprised of members from each of the Utilities and Rate Counsel) meetings to further refine program design details. There will also be ongoing stakeholder opportunities for the public to provide feedback coordinated by Staff.

Staff also recommends continuing to utilize the following working groups and committees.

Workforce Development Working Group ("WFD WG"): The WFD WG comprises Staff, Rate Counsel, the Utilities, EE suppliers, job training institutions and organizations, equity stakeholders, other State and local agencies, and organizations and representatives from the other EE working groups as appropriate. This working group develops recommendations for coordinated and collaborative workforce development and job training pathways and pipelines statewide, with a focus on providing economic opportunities for underrepresented and socially or economically disadvantaged individuals. Underrepresented and socially or economically disadvantaged individuals may include women, people of color, veterans, disabled, and formerly incarcerated individuals, as well as those who are unemployed, underemployed, or low- and moderate-income. Programs may include contractor and subcontractor coaching and mentoring of underrepresented, disadvantaged, and small business enterprises.

Equity Working Group ("EWG"): The EWG comprises stakeholders from representative organizations across the state familiar with the intersection of energy, equity, and health issues, as well as representatives from each of the other working groups. This working group is responsible for developing recommendations for integrating equity metrics and approaches in EE and PDR programs for Utility-run and State-run programs. The EWG collaborates with the Supplier Diversity Development Council on recommendations for increasing economic development opportunities for minority-, women-, and veteran-owned businesses, including through, but not limited to, procurement policies for contractors and subcontractors.

Evaluation, Measurement, and Verification Working Group ("EM&V WG"): As described in Section VII(A) above, as facilitated by the SWE, the EM&V WG brings together Staff, Rate Counsel, and the Utilities – with technical evaluation contractors, program implementation contractors, and representatives from the other EE working groups as appropriate to provide guidance and input on relevant issues – to collaborate to develop a standard, transparent, and replicable approach for evaluating, measuring, and verifying the results of EE and PDR programs implemented pursuant to the CEA. As part of this standard statewide approach, the State and Utilities are held to the same accountability standards through collaboratively developed plans, schedules, procedures, guidelines, and requirements for program administrators. The EM&V WG share associated data, as appropriate, consider best practices from other jurisdictions, and facilitate the necessary stakeholder processes related to the State's EM&V policies. The EM&V WG is highly deliberative and advisory regarding key EM&V plans and recommendations, and provides recommendations to Staff, with the Board retaining ultimate decision-making authority.

The EM&V WG establishes committees as needed on targeted issues. The current committees are the TRM Committee, NJCT Committee, and Guidelines Committee, with each comprising various members of the EM&V WG. Please see Sections VII(D) and VII(E) above for more detail. Staff recommends increasing the frequency of EM&V WG updates and discussions with public stakeholders through EE stakeholder meetings.

Marketing Working Group ("MWG"): The MWG consists of the State and Utilities, as well as any relevant partners, and works to promote the programs and the benefits of participation in the programs through coordinated messaging about core programs and a simplified experience for customers and contractors. Utilities and Staff engage in a collaborative effort in branding, messaging, and promotion of all Utility- and State-led programs, including in the provision of program materials in Spanish and other languages other than English. Staff leverages State resources to promote general awareness of EE and other clean energy opportunities in New Jersey while the Utilities and State program administrator market specific programs and initiatives to customers in a more targeted fashion.

DISCUSSION AND FINDINGS

The Board **FINDS** that the processes utilized in developing Staff's recommendations were appropriate and provided stakeholders and interested members of the public with adequate notice and opportunity to comment.

The Board has reviewed the stakeholder comments and Staff's recommendations. The Board **FINDS** that Staff's recommendations will benefit New Jersey's residents, energy users, ratepayers, and electric and gas public utilities and are consistent with the goals of the Clean Energy Act, the EMP, and other relevant laws and policy authorities. Therefore, the Board **HEREBY APPROVES** Staff's recommendations, with specific directives included below.

I. Program Administration

A. Program Years

The Board **ACCEPTS** Staff's recommendation that Triennium 2 comprise the following three (3) program years:

PY25: July 1, 2024–June 30, 2025
PY26: July 1, 2025–June 30, 2026
PY27: July 1, 2026–June 30, 2027

B. *Utility-Led Programs*

i. Utility Core Programs

The Board **DIRECTS** the Utilities to administer a suite of core programs that serve the residential, multifamily, and C&I sectors in the manner detailed above and that are consistently available throughout New Jersey, as recommended by Staff. The Board **ACCEPTS** Staff's recommendations that the Utilities shall ensure that all programs provide comprehensive EE opportunities for existing buildings, including, where appropriate, in-depth energy assessments and incentives for whole building EE and electrification solutions, as detailed above. In particular, the Board **DIRECTS** the Utilities to include specific opportunities for LMI and OBC customers, including tenants, in residential and multifamily programs, as well as for small commercial customers and public entities, as detailed above. In addition, the Board **ACCEPTS** Staff's recommendation that the Utilities be allowed to propose to administer Comfort Partners and notes that the Board intends to closely examine the Utilities' proposals regarding net benefits and costs to program participants and ratepayers, as well as continuation of sufficient budgets for the program.

ii. Additional Utility Initiatives (RESERVED)

iii. Consistency in Program Elements and Design Standards

The Board **DIRECTS** the Utilities to offer core programs that include coordinated program elements, as recommended by Staff. The Board views these elements as important to ensure consistency of core program delivery, which will streamline and ease participation by customers and contractors, while advancing key policy goals such as improving access to programs by LMI and OBC customers, and expanding opportunities for EE jobs for local, underrepresented, and disadvantaged workers and businesses.

The Board also **DIRECTS** Staff and the Utilities to continue to engage in a collaborative effort in consistent branding, messaging, and promotion of all Utility- and State-led programs, including in the provision of program materials in Spanish and other languages in addition to English.

iv. Budgeting Based on Commitments

The Board **ACCEPTS** Staff's recommendation regarding Utility budgeting based on commitments.

v. Joint Utility Coordination

In areas where electric and gas service territories overlap, the Board **DIRECTS** the Utilities to design a program structure that results in coordinated, consistent delivery of programs among all Utilities and allocates costs and energy savings appropriately based on the fuel type(s) treated by EE measures. The Board also **DIRECTS** the Utilities to continue to jointly plan and coordinate budgets in overlapping Utility territories, as recommended by Staff.

vi. Flexibility

Regarding adjustments to program budgets and incentives, the Board continues to seek to strike a balance between allowing Utilities sufficient freedom to quickly make adjustments in response to changing market demands, on the one hand, at the same time as retaining Staff and Board review of changes above certain thresholds. The Board therefore **ADOPTS** Staff's recommendations on budget and incentive adjustments to Utility-led programs.

C. State-Led Programs and Initiatives

The Board **ACCEPTS** Staff's recommendation for the State to administer a series of complementary programs serving the market sectors and addressing the areas detailed above.

D. Workforce Development

The Board and Staff should continue to coordinate with State agencies and other entities to develop statewide workforce development pathways and other initiatives, including for local, underrepresented, and disadvantaged individuals and communities. The Board **ACCEPTS** Staff's recommendation that the Utilities work in collaboration with the Workforce Development Working Group to support the continued development and implementation of workforce development and job training partnerships and pipelines that recruit, train, and employ residents for EE jobs. More specifically, the Board **ACCEPTS** Staff's recommendations, which include pursuing a complementary approach between State-funded and Utility-funded initiatives, with State support for competitive grants to community-based organizations to provide core employment and training services (including wrap-around supportive services) and intensive employment and training services (including on-the-job training placements), as well as Utility-funded training programs developed in consultation with the EE Workforce Development Working Group.

E. Coordination Between Utility-Led and State-Led Programs

When Utility-led and State-led programs overlap in their service to the same customers, program administrators should collaborate with the goal of achieving coordinated, streamlined program delivery for customers. The Board therefore **ACCEPTS** Staff's recommendation and **DIRECTS** program administrators of Utility-led and State-led programs to coordinate and adjust their respective program rules as needed to simplify the process for customers when the programs overlap in their service to the same customers. The Board also **ACCEPTS** Staff's specific recommendations regarding ESIP projects due to the importance of ensuring coordination on projects that participate in both ESIP and Utility EE incentive programs.

II. Program Funding

The Board **AGREES** with Staff that the State and Utilities should explore and pursue additional State and federal funding that supports and complements New Jersey's existing EE programs and defrays burdens on ratepayers. Following the Board's receipt of guidance from the U.S. Department of Energy on Inflation Reduction Act funding for efficiency and electrification rebates, the Board **DIRECTS** Staff and Utility and State program administrators to work with Rate Counsel and other stakeholders to propose for feedback from public stakeholders how to most efficiently and effectively leverage this additional funding to maximize the benefits of existing programs. The Board **DIRECTS** Staff to work with program administrators and implement needed adjustments to Utility and State program design and delivery that are consistent with the goals and requirements of this Order.

III. Goals, Targets, Performance Incentive Mechanism (Reserved)

IV. Filing Requirements

A. Utility Program Filings, MFRS

The Board **FINDS** that Staff's recommended revisions to the MFRs increase clarity and simplicity in the requirements for program filing. The Board therefore **ADOPTS** the revised MFRs and directs the Utilities to file three-year program petitions, as recommended by Staff, with consistent organizational structures and common elements that will facilitate more streamlined review, by October 2, 2023 for approval by the Board by May 1, 2024 and implementation beginning July 1, 2023.

B. State Program Filings

The Board recognizes the benefits of aligning plans for State-led programs with plans for Utility-led programs for each three-year program cycle. The Board therefore **ACCEPTS** Staff's recommendations and **DIRECTS** Staff to work with NJCEP's program administrator to develop three-year NJCEP program plans based on the State's performance targets in coordination with Utility program administrators and stakeholders as appropriate, file those plans with the Board every three (3) years as part of the NJCEP annual budget process, and update each three-year plan on an annual basis to confirm each year's program budget, subject to allocations based on the CRA process.

C. Utility Annual Compliance Petitions

The Board **DIRECTS** each Utility to submit its annual compliance filing no later than 150 days following the end of each program year, as recommended by Staff, and **APPROVES** Staff's recommendation that Staff may adjust the filing due date as appropriate.

V. Cost Recovery

A. Program Costs

The Board **DIRECTS** each Utility to annually file to recover on a full and current basis, through a surcharge, all reasonable and prudent costs incurred as a result of EE and PDR programs, including but not limited to recovery of and on capital investment.

B. *Investment Treatment*

Regarding investment treatment, the Board agrees with Staff's reasoning and **ADOPTS** Staff's recommendations on the following aspects of cost recovery of program investments: amortization of program investments that aligns with the weighted average useful life of each Utility's proposed portfolio but not to exceed 10 years; no cap at this time on the customer distribution rates or customer bills associated with program investments; and use of the capital structure established in each Utility's most recent base rate case as the carrying costs for program investments, incorporating both the cost of debt and the ROE, with no basis point reduction on the ROE.

C. Lost Revenue Treatment

The Board **ADOPTS** Staff's recommendations that the Utilities be able to file for and recover potential lost revenues in the amount that they can demonstrate were attributable to Utility-run EE and PDR programs, using either an LRAM or CIP and limited through an earnings test. The Board **APPROVES** Staff's recommendation to make no changes to the LRAM or CIP mechanisms at this time but to explore potential changes as part of the next triennial review period. The Board also **ADOPTS** Staff's recommendation and **DIRECTS** the Utilities to file a base rate case no later than five (5) years after the commencement of an approved EE program in order to update usage projections and reset lost revenues, as recommended.

VI. Energy Efficiency As a Resource

As part of the cost recovery for EE programs, the Board continues to be focused on ensuring reasonable rates for ratepayers, especially those ratepayers funding the underlying cost of EE programs. The Board **ADOPTS** Staff's recommendations related to EE as a resource in the PJM FCM that the Board expects will result in benefits to New Jersey customers by obtaining revenues that offset the cost EE programs. More specifically, the Board **DIRECTS** the public electric utility companies to offer EE resources for program years within the Triennium 2 program cycle into the eligible FCM BRAs. The Board also **ALLOWS** the public electric utility companies to offer EE resources from core programs in program years that are beyond the currently approved three-year budget for the EE/PDR programs, beginning with the 2026/2027 BRA, as recommended by Staff. The Board **ADOPTS** Staff's recommendation that a Utility may seek a waiver of the requirement based on the Utility's assessment that such bidding would not be cost-effective.

VII. Evaluation, Measurement, and Verification

The Board **ACCEPTS** the TRM and NJCT for Triennium 2, as recommended by Staff. The Board also notes that the Board will provide specific directives and guidance on the topic of net vs. gross energy savings relative to assessment of compliance with CEA goals when it addresses the remaining aspects of the Triennium 2 framework pertaining to goals, targets, and the performance incentive mechanism.

VIII. Reporting Requirements

The Board **DIRECTS** the Utilities and Staff to submit public reports to the Board according to Staff's recommendations for quarterly progress reports, annual progress reports, triennial progress reports, and statewide compilation reports on the performance and progress of the EE programs.

IX. Triennial Review

The Board **DIRECTS** Staff to continue to undertake a triennial review process, as recommended, to review and establish metrics, the associated weighting structure, and utility and State performance targets for each PY until all cost-effective energy efficiency has been achieved in a given Utility territory. The Board also **DIRECTS** Staff to continue to use the triennial review process to review the cost recovery mechanism, including the incentive and penalty structure, program administration and design, and costs to achieve EE program goals.

X. Stakeholder Groups

The Board **DIRECTS** Staff to continue to use the following working groups and committees: (1) Workforce Development Working Group, (2) Equity Working Group, (3) EM&V Working Group, and (4) Marketing Working Group, as recommended by Staff. In particular, the Board **ACCEPTS** Staff's recommendations to increase the frequency of EM&V WG updates and discussions with public stakeholders through EE stakeholder meetings.

XI. Regulations

Overall, the Board sees the Triennium 2 EE framework as closely tracking the directives of the CEA, as opposed to adding any new or additional requirements. The Board's view is also that, while the CEA expressly authorizes myriad aspects of this EE framework, and while many other aspects of the framework are obviously inferable from the specific language of the CEA, the Board acknowledges that certain requirements applicable to the regulated community of electric and gas public utilities in the CEA necessitated clarification or explanation to facilitate compliance with the CEA.

The Board also notes that stakeholders and interested parties have had multiple and ongoing opportunities to review and comment on all facets of the EE framework and its requirements.

Taking all of these aspects of the EE framework into consideration, the Board **DETERMINES** that the EE framework should be codified while the State, public utilities, and stakeholders continue to collaborate to advance implementation of the CEA.

The Board therefore **DIRECTS** Staff to take necessary steps to immediately initiate a rulemaking process to adopt the EE framework contained herein through administrative rules.

Agenda Date: 5/24/23
Agenda Item: 8B

The effective date of this order is June 5, 2023.

DATED: May 24, 2023

BOARD OF PUBLIC UTILITIES
BY:

JOSEPH L. FIORDALISO
PRESIDENT

MARY-ANNA HOLDEN
COMMISSIONER

DIANNE SOLOMON
COMMISSIONER

DR. ZENON CHRISTODOULOU
COMMISSIONER

ATTEST:

SHERRI L. GOLDEN
SECRETARY

I HEREBY CERTIFY that the within document is a true copy of the original in the files of the Board of Public Utilities.

IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, C. 17, THE NEW JERSEY CLEAN ENERGY ACT OF 2018, REGARDING THE ESTABLISHMENT OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS, DOCKET NO. QO19010040

IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, C. 17, THE NEW JERSEY CLEAN ENERGY ACT OF 2018, REGARDING THE SECOND TRIENNIUM OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS, DOCKET NO. QO23030150

IN THE MATTER OF ELECTRIC PUBLIC UTILITIES AND GAS PUBLIC UTILITIES OFFERING ENERGY EFFICIENCY AND CONSERVATION PROGRAMS, INVESTING IN CLASS I RENEWABLE ENERGY RESOURCES AND OFFERING CLASS I RENEWABLE ENERGY PROGRAMS IN THEIR RESPECTIVE SERVICE TERRITORIES ON A REGULATED BASIS, PURSUANT TO N.J.S.A. 48:3-98.1 AND N.J.S.A. 48:3-87.9 – MINIMUM FILING REQUIREMENTS, DOCKET NO. QO17091004

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In the Matter of the Implementation of P.L. 2018, c. 17, the New Jersey Clean Energy Act of 2018 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs
Docket No. QO19010040

In the Matter of the Implementation of P.L. 2018, c. 17, the New Jersey Clean Energy Act of 2018, Regarding the Second Triennium of Energy Efficiency and Peak Demand Reduction Programs
Docket No. QO23030150

In the Matter of Electric Public Utilities and Gas Public Utilities Offering Energy Efficiency and Conservation Programs, Investing in Class I Renewable Energy Resources and Offering Class I Renewable Energy Programs in Their Respective Service Territories on a Regulated Basis Pursuant to N.J.S.A. 48:3-98.1 and N.J.S.A. 48:3-87.9 – Minimum Filing Requirements
Docket No. QO17091004

MINIMUM FILING REQUIREMENTS FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY PETITIONS UNDER N.J.S.A. 48:3-98.1 AND N.J.S.A 48:3-87.9

I. General Filing Requirements

a. The utility shall provide a table of contents for each filing.

b. The utility shall provide with all filings, information and data pertaining to the specific program proposed, as set forth in applicable sections of N.J.A.C. 14:1-5.11 and N.J.A.C. 14:1-5.12.

c. All filings shall contain information and financial statements for the proposed program(s) in accordance with the applicable Uniform System of Accounts that is set forth in N.J.A.C. 14:1-5.12. The utility shall provide the accounts and account numbers that will be utilized in booking the revenues, costs, expenses, and assets pertaining to each proposed program so that they can be properly separated and allocated from other regulated and/or other programs.

d. The utility shall provide supporting explanations, assumptions, calculations, and work papers as necessary for each proposed program and cost recovery mechanism petition filed under N.J.S.A. 48:3-98.1. The utility shall provide electronic copies of such supporting information, with all inputs and formulae intact, where applicable.

e. The filing shall include testimony supporting the petition, including all proposed programs.

f. For any proposed program, the utility shall be subject to the requirements in this and all subsequent Sections. If compliance with Section V and VI of these requirements would not be feasible for a particular program or sub-program, the utility may request an exemption but must demonstrate why such exemption should be granted. Examples of historical situations that have qualified for exemption include pilot programs, programs that had an educational or policy goal rather than resource

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acquisition focus, and programs that introduced novel ideas where documentation supporting estimated costs/benefits may not be easily produced.

g. If the utility is filing for an increase in rates, charges, etc. or for approval of a program that may increase rates/changes to ratepayers in the future, the utility shall include a draft public notice with the petition and proposed publication dates.

II. Program Description

a. The utility shall provide a detailed description of each proposed program for which the utility seeks approval, including, if applicable:

i. Program description/design
ii. Target market segment – including eligible customers, properties, and measures/services – and eligibility requirements and processes
iii. Existing incentives
iv. Proposed incentive structure or incentive ranges, including incentive payment processes and timeframes
v. Customer financing options
vi. Contractor requirements and role: The utility shall provide a description of the extent to which the utility intends to utilize employees, contractors, or both to deliver the program(s). The utility shall also provide a description of contractor requirements, including common application elements and training requirements.
vii. Estimated program participants, by year
viii. Projections for energy savings and associated metrics for each program year relative to the quantitative performance indicators in Section VII.
ix. Program budget, by year
x. Projected program costs, by year, broken down into the following categories, as applicable:
    - capital cost;
    - utility administration;
    - marketing and outreach;
    - outside services;
    - incentives (including rebates and low- or no-interest loans);
    - inspections and quality control; and
    - evaluation.

    To the extent that the New Jersey Board of Public Utilities ("Board" or "BPU") directs New Jersey's Clean Energy Program ("NJCEP") to report additional categories, the utility shall provide additional categories, as applicable.

    Any workforce development and job training costs, health and safety costs, and costs of outreach to community-based organizations shall be shown separately.

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b. The utility shall provide the following information about the proposed portfolio:

   i. Quality assurance and control standards and remediation policies: The utility shall provide a detailed description of the process(es) for ensuring the quality of the programs and resolving any customer complaints related to the program(s).
   ii. Plan for workforce development and job training partnerships and pipelines for energy efficiency jobs, including for local, underrepresented, and disadvantaged workers. The utility will also provide a description of how the utility plans to engage with and support participation by minority-, women-, and veteran-owned and other underrepresented businesses to ensure equitable access to contracting opportunities under the proposed programs.
   iii. Customer access to current and historic energy usage data
   iv. Total budget summary, including an annual budget summary and joint budgets with partner utilities
   v. Benefit-cost analysis (as defined in Section V)
   vi. The utility shall list its forecasted average cost to achieve each unit of energy savings in each sector.
   vii. Marketing plan: The utility shall provide a description of where and how the proposed portfolio will be marketed or promoted to the sectors served by the utility's customer base, including coordinated customer outreach on core programs with other utilities. This shall include an explanation of how the specific services, along with prices, incentives, and energy bill savings for the proposed portfolio, will be conveyed to customers, where available and applicable. The marketing plan shall also include a description of any known market barriers that may impact implementation and strategies to address known market barriers.

c. In areas where gas and electric service territories overlap, the utility shall provide a description of the program structure for coordinated, consistent delivery of programs between the utilities and estimated coordinated budgets and allocation of costs and energy savings between the utilities. The utility shall provide a description of how the utilities coordinated their program assumptions and other factors that could influence results for each coordinated program.

III. Additional Filing Information Applicable Only to Renewable Energy Projects

a. The utility shall propose the method for treatment of Renewable Energy Certificates ("RECs"), including solar incentives, or any other renewable energy incentive developed by the Board, including Greenhouse Gas Emissions Portfolio and Energy Efficiency Portfolio Standards including ownership and use of the certificate revenue stream(s).

b. The utility shall also propose the method for treatment of any air emission credits and offsets, including Regional Greenhouse Gas Initiative carbon dioxide allowances and offsets, including ownership and use of the certificate revenue stream(s). For programs that are anticipated to reduce electricity sales in its service territory, the utility shall quantify the expected associated annual savings in REC, solar incentive, and any other renewable energy incentive costs.

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IV. Cost Recovery Mechanism

a. The utility shall provide appropriate financial data for the proposed program(s), including estimated revenues, expenses, and capitalized investments for each of the first three years of operations and at the beginning and end of each year of the three-year period. The utility shall include pro forma income statements for the proposed program(s) for each of the first three years of operations and actual or estimated balance sheets at the beginning and end of each year of the three-year period.

b. The utility shall provide detailed spreadsheets of the accounting treatment of the proposed cost recovery, including describing how costs will be amortized, which accounts will be debited or credited each month, and how the costs will flow through the proposed program cost recovery method.

c. The utility shall provide a detailed explanation, with all supporting documentation, of the recovery mechanism it proposes to utilize for cost recovery of the proposed program(s), including proposed recovery through the Societal Benefits Charge, a separate clause established for these programs, base rate revenue requirements, government funding reimbursement, retail margin, and/or other mechanisms.

d. The utility's petition for approval, including proposed tariff sheets and other required information, shall be verified as to its accuracy and shall be accompanied by a certification of service demonstrating that the petition was served on the New Jersey Division of Rate Counsel simultaneous to its submission to the Board.

e. The utility shall provide a rate impact summary by year for the proposed program(s) and a cumulative rate impact summary by year for all approved and proposed programs showing the impact of individual programs, based upon a revenue requirement analysis that identifies all estimated program costs and revenues for each proposed program on an annual basis. Such rate impacts shall be calculated for each customer class. The utility shall also provide an annual bill impact summary by year for each program, and an annual cumulative bill impact summary by year for all approved and proposed programs showing bill impacts on a typical customer for each class.

f. The utility shall provide, with supporting documentation, a detailed breakdown of the total costs for the proposed program(s), identified by cost segment, consistent with the program cost categories enumerated in Section II(a)(x). This shall also include a detailed analysis and breakdown and separation of the embedded and incremental costs that will be incurred to provide the services under the proposed program(s), with all supporting documentation. Embedded costs are costs that are provided for in the utility's base rates or through another rate mechanism. Incremental costs are costs associated with or created by the proposed program that are not provided for in base rates or another rate mechanism.

g. The utility shall provide a detailed revenue requirement analysis that clearly identifies all estimated annual program costs and revenues for the proposed program(s), including effects upon rate base and pro forma income calculations.

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h. The utility shall provide, with supporting documentation: (i) a calculation of its current capital structure, as well as its calculation of the capital structure approved by the Board in its most recent electric and/or gas base rate cases, and (ii) a statement as to its allowed overall rate of return approved by the Board in its most recent electric and/or gas base rate cases.

i. If the utility is seeking carrying costs for a proposed program, the filing shall include a description of the methodology, capital structure, and capital cost rates used by the utility. A utility seeking performance incentives shall provide all supporting justifications and rationales for the incentives, along with supporting documentation, assumptions, and calculations. Utilities that have approved rate mechanisms or incentive treatment from previous cases and are not seeking a modification of such treatment through the current filing are not subject to this requirement.

V. Benefit-Cost Analysis

a. The utility shall conduct a benefit-cost analysis of the programs and portfolio using the most recent New Jersey Cost Test, including its most recent avoided cost methodologies, as a primary test. In addition, the utility shall conduct benefit-cost analysis using the Participant Cost Test, Program Administrator Cost Test, Ratepayer Impact Measure Test, Total Resource Cost Test, and Societal Cost Test that assesses all program costs and benefits from a societal perspective i.e., that includes the combined financial costs and benefits realized by the utility and the customer as defined in the then-current version of the California Standard Practice Manual. The utility may also provide any additional benefit-cost analysis that it believes appropriate with supporting rationales and documentation.

b. The utility must demonstrate how the results of the tests in Section V(a) support Board approval of the proposed program(s), including how the programs are designed to achieve a benefit-to-cost ratio greater than or equal to 1.0 at the portfolio level when using the New Jersey Cost Test.

c. Renewable energy programs, workforce development and job training costs, health and safety measures, and outreach to community-based organizations shall not be subject to a benefit-cost test, but the utility must estimate all direct and indirect benefits resulting from such a proposed program as well as provide the projected costs.

d. The level of energy and capacity savings shall be calculated using the most recent Technical Reference Manual approved by the Board. To the extent that a protocol does not exist or an alternative protocol is proposed for a filed program, the utility must submit a savings methodology for the program or contemplated measure for approval by the Board.

e. For calculation of energy and capacity savings, as well as for cost effectiveness calculations, the utility shall apply the applicable net-to-gross ("NTG") ratio and realization rates provided in the current Technical Reference Manual. To the extent that a NTG value does not exist or an alternative NTG value is proposed for a filed program, the utility must submit a NTG value for the program or contemplated measure for approval by the Board.

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VI. Evaluation, Measurement, and Verification ("EM&V")

a. The utility shall describe the methodology, processes, and strategies for monitoring and improving program and portfolio performance related to the utility's targets established pursuant to the Quantitative Performance Indicators ("QPIs") in Section VII. The utility shall confirm that these methodologies, processes, and strategies conform with the current New Jersey EM&V guidance documents and standards. The utility shall also provide an EM&V budget consistent with the current New Jersey EM&V guidance documents and standards.

VII. Quantitative Performance Indicators: Targets

a. The utility shall file QPI target values based on the metrics applicable to each program year of the three-year program filing cycle.

b. The utility shall provide a description of how the proposed portfolio achieves the targets established for each utility pursuant to the QPIs outlined in the BPU's most recent Energy Efficiency Framework Order, as applicable for each program year:

VIII. Reporting Plan: The utility shall comply with the reporting requirements as outlined in the BPU's most recent Energy Efficiency Framework Order.

In the Matter of the Implementation of P.L. 2018, c. 17, the New Jersey Clean Energy Act of 2018, Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, Docket No. QO19010040

In the Matter of the Implementation of P.L. 2018, c. 17, the New Jersey Clean Energy Act of 2018, Regarding the Second Triennium of Energy Efficiency and Peak Demand Reduction Programs, Docket No. QO23030150

In the Matter of Electric Public Utilities and Gas Public Utilities Offering Energy Efficiency and Conservation Programs, Investing in Class I Renewable Energy Resources and Offering Class I Renewable Energy Programs in Their Respective Service Territories on a Regulated Basis Pursuant to N.J.S.A. 48:3-98.1 and N.J.S.A. 48:3-87.9 – Minimum Filing Requirements, Docket No. QO17091004

STAFF RESPONSES TO STAKEHOLDER COMMENTS ON STRAW PROPOSAL

LIST OF COMMENTERS

Aeroseal
Building Performance Association ("BPA")
Ceres and members of the Business for Innovative Climate Energy Policy Network ("Ceres")
Dandelion
Franklin Energy
Energy Efficiency Alliance of New Jersey ("EEA-NJ")
Google LLC ("Google Nest")
Mr. Robert Erickson ("Mr. Erickson")
MaGrann
Honeywell
Jersey Central Power & Light Company ("JCP&L")
Ms. Patricia Miller ("Ms. Miller")
Natural Resources Defense Council ("NRDC")
NJ 50x30 Building Electrification ("NJ 50x30")
New Jersey Business & Industry Association ("NJBIA")
New Jersey Division of Rate Counsel ("Rate Counsel")
New Jersey Large Energy Users Coalition ("NJLEUC")
New Jersey Natural Gas Company ("NJNG")
New Jersey Utilities Association ("NJUA")
Northeast Energy Efficiency Partnerships ("NEEP")
Public Service Electric & Gas Company ("PSE&G")
Recurve
Rockland Electric Company ("RECO")
South Jersey Industries Utilities ("SJIU")
Span, Inc. ("SPAN")
Tri-State Light & Energy ("TSLE")
Uplight
Mr. Michael Winka ("Mr. Winka")

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GENERAL COMMENTS

Comments: Rate Counsel recognized that the first straw proposal circulated by Staff (on program administration and design, filing and reporting requirements, cost recovery, and energy efficiency as a resource) was the product of extensive and detailed stakeholder process, in which Rate Counsel was a participant. Rate Counsel noted that, although not all aspects of this straw proposal are consistent with Rate Counsel's policy preferences, Rate Counsel views them as representing a balancing of interests toward full implementation of New Jersey's diverse and ambitious clean energy goals, including ensuring opportunity for participation by all customers, reasonable extra support for low- and moderate-income ("LMI") customers, and broad opportunities for workforce and contracting partner participation for all New Jersey residents and businesses. While expressing support for these goals, Rate Counsel emphasized the importance of the Board maintaining low utility costs as a fundamental equity consideration for LMI customers as New Jersey's clean energy initiatives become increasingly ambitious and the State strives to be a leader in combatting climate change. In particular, Rate Counsel urged the Board to be mindful of how much of the costs of fostering a clean energy economy should be borne by ratepayers as many initiatives may stray from traditional utility functions. On a related note, Rate Counsel argued that, as clean energy technology evolves (noting as an example how compact fluorescent lightbulbs have transitioned to light-emitting diode lightbulbs), ratepayers should not bear the burden of paying for assets that become obsolete long before their anticipated useful lives have ended and therefore become stranded costs. Rather, Rate Counsel argued that ratepayers should pay for investments that directly support the provision of energy that they need on a least-cost basis, including proven strategies for saving energy and reducing their bills.

NJUA noted that the Utilities have learned a great deal during the first half of Triennium 1 as the Utilities worked to transfer the majority of the energy efficiency ("EE") programs previously offered by New Jersey's Clean Energy Program ("NJCEP") to Utility management. The Utilities noted that they are proud to have expanded the portfolio to include new programs and features across the state, including elements like financing or on-bill repayment and supplemental incentives for LMI customers to make EE more accessible to everyone. NJUA expressed general support for the first straw proposal.

PSE&G expressed appreciation for Staff's hard work on the first and second straw proposals, with particular appreciation for the time spent in working groups and other forums engaging with the Utilities and other stakeholders related to Triennium 2.

Franklin Energy expressed that it stands in support of the BPU, its staff, and the overall program goals, as they have seen several states across the country move the needle toward net zero through such efforts.

SPAN supported the direction and intent of the straw proposal.

NRDC characterized New Jersey's EE programs as a cornerstone of New Jersey's clean energy policy, offered praise for the great success in the past three years of rapidly expanding EE and conservation programs, and opined that the Triennium 2 programs should now be harmonized with the broader clean energy landscape in New Jersey. NRDC recommended that the Triennium 2 straw proposal should clearly articulate that EO 316 and broader State energy policy are the starting point for Triennium 2 program priorities, strategies, and design.

NJ 50x30 asserted that EE and PDR programs need to be managed and delivered in an integrated manner along with the Board's electric vehicle ("EV") and solar/storage programs, especially for low-income households in environmentally disadvantaged areas, in order to meet the State's 100% clean energy goals. NJ 50x30 also stated that the Board should require the Utilities to provide general information and specific program rebates about State and federal EV and solar/battery incentives.

Mr. Winka also called for coordinated delivery of the Utility EE and PDR programs as an integral part of a fully integrated, holistic clean energy initiative approach, especially for low-income households, that includes high efficiency buildings and vehicles through advanced building and transportation electrification powered by renewable energy with storage and connected through grid-interactive efficient buildings.

Response: Staff appreciates the general support for Staff's proposals.

Staff acknowledges Rate Counsel's and the Utilities' deep and thoughtful engagement in the stakeholder process that produced Triennium 2 straw proposals that were designed to build on the experiences and lessons learned from the first half of Triennium 1 as the Board continues to strive to support achievement of New Jersey's ambitious clean energy goals in a balanced, thoughtful, and thorough manner.

Staff appreciates NRDC's comments and recommendations calling for more context about New Jersey's broader clean energy policy landscape, which is included in the Board Order adopting certain aspects of the Triennium 2 framework.

Staff also acknowledges NJ 50x30's and Mr. Winka's vision of a fully integrated approach to advancing clean energy in New Jersey, including through buildings. Staff also imagines that the commenters understand the challenges in State government with getting to full integration but looks forward to continuing discussion to identify ways and methods to facilitate increasing integration of State-supported strategies over time, including through the work of the Clean Buildings Working Group and possible future proceedings on demand response and advanced metering infrastructure ("AMI").

I. PROGRAM ADMINISTRATION

A. Program Years ("PYs")

Comments: Staff received no specific comments on this topic.

B. Utility-Led Programs

i. Utility Core Programs

Comments: PSE&G stated support for the proposal that the Utilities continue to implement all of the programs currently offered within the Utility program portfolio, noted their success in implementing these programs during Triennium 1, and expressed confidence in their ability to continue to maximize EE through Utility administration of the EE programs.

NEEP suggested that BPU should consider statewide alignment of Utility core programs to ensure equitable access to program benefits and incentives for all residents of the State.

While acknowledging that Utility flexibility is important in program design, Aeroseal suggested that, to support achievement of New Jersey's Clean Energy Act of 2018 ("CEA") and New Jersey's Energy Master Plan ("EMP") goals on the path toward decarbonization, maximize ratepayer benefits, and maintain energy affordability, BPU should require Utilities to prioritize a set of core EE programs and measures to be offered in homes and businesses. They noted Connecticut's Advanced Duct Sealing rebate program as a potential model. Second, Aeroseal stated that the BPU should encourage Utilities to update program offerings and delivery mechanisms to achieve more meaningful energy savings in the multifamily sector. For example, Aeroseal noted that the Utilities should work with landlords to take advantage of turnover to comprehensively weatherize multifamily units. Third, Aeroseal recommended a rolling qualification process for contractor certification in order to expand near-term participation and support high satisfaction, which are both critical elements of EE program success. Fourth, Aeroseal stated that the BPU should ensure that Utility programs, technical support, and incentives can layer into the Comfort Partners and Whole House programs to support equity-eligible residents.

Aeroseal also asserted that Utility programs should take a whole-home, efficiency-first approach to electrification by incentivizing the bundling efficiency and electrification measures. More specifically, Aeroseal recommended that program implementers offer higher financial incentives to homeowners, building owners, and contractors to bundle building shell upgrades, such as duct and envelope sealing, with complementary measures like heat pump installation in order to achieve deeper energy and cost savings, improve participant comfort, ensure resident comfort and acceptance of heat pump technology, and have greater potential to reduce energy burdens and GHG emissions. Aeroseal also recommended that building shell upgrades can be bundled with electrification-readiness measures that will enable households to more affordably and efficiently electrify later.

Dandelion advocated that Triennium 2 programs should include whole-home geothermal heat pump incentives of at least $15,000 per home or per ton incentives of at least $2,000 per ton to appropriate incentivize geothermal systems for their full EE benefits. Dandelion also noted that geothermal heat pump incentives should be similarly integrated into the BPU's new construction program.

EEA-NJ expressed appreciation for the inclusion of behavioral solutions as a core principle in Triennium 2, describing it as a low-cost, data-driven measure that provides individualized recommendations to save money and energy on customer utility bills and complements the other residential core programs.

Recurve recommended that the Board include an expectation that Utility proposals use the best practice of data-driven, meter-based customer targeting to deliver the most cost-effective savings available, including for LMI customers. Recurve asserted that meter-based targeting can identify customers with the highest savings potential, provide insights into potential bill savings, and help mitigate the increased energy burden from electrification. Recurve stated that using energy consumption data to develop customer parameters for high- and low-savers and sharing those insights with participating contractors and aggregators supports them in delivering measurable results.

SPAN strongly supported the inclusion of residential incentives for whole home EE and electrification solutions as a Utility core program, noting that whole home electrification is essential to meeting New Jersey's emissions goal and supports the transition of household appliances from natural gas to electricity and installing rooftop solar, battery storage, and electric vehicle chargers. More specifically, SPAN recommended that the Utilities develop incentives for panels, such as smart panels, that can make-ready a home for whole-home electrification and serve as a facilitator of whole-home demand response. SPAN asserted that smart panels are often the least costly way to make homes ready for electrification. For example, SPAN asserted that smart panel incentives for income-eligible customers can massively reduce or eliminate the cost of or need for electrical upgrades. SPAN also noted that, compared to basic panels, smart panels can reduce load across each individual circuit, reducing peak demand on the grid. In addition, SPAN noted that smart panels would not require smart meters or access to smart meter data because the smart panel can calculate revenue-grade meter data independently due to its visibility into every single load consumed by the home. Specifically, SPAN recommended that customers should be able to easily bundle smart panel upgrades with other related measures, such as the replacement of gas appliances and that installers should be informed and incentivized to offer and install smart panels.

Uplight was pleased to see a continuation of the core programs for Utilities, particularly online marketplaces and behavioral solutions, noting that having the same or similar programs allows knowledge and participation in the programs to grow over time. Additionally, Uplight stated that prioritizing LMI and multifamily programs will be beneficial for those often underserved segments and stated that there should be dedicated programs to reach these populations as well as specific targeting and utilization of the residential core programs for LMI and multifamily households.

NRDC recommended that the Triennium 2 framework should include more detailed program requirements designed to achieve EO 316 targets rather than have discussions about program design elements occur as part of the Utility plan filing process, including because of the tight deadlines and limited stakeholder participation in that process.

NJ 50x30 argued that Comfort Partners should also enable zero energy home retrofits that include heat pump appliances, EV charging, and solar with storage.

Similarly, Mr. Winka asserted that Utilities should be required to develop zero energy ready homes and zero energy ready small business retrofit programs that include heat pump appliances, induction stoves, EV charging equipment, solar and storage, electrical panel upgrades, and grid interactive building technologies as part of their whole building EE programs. Ms. Miller called for building, EV, and solar/clean energy programs to be designed and operated in a coordinated way for customers and the grid.

NJ 50x30, Ms. Miller, and Mr. Winka called for stronger incentives for building electrification technologies. Ms. Miller called for sufficient funding to incentivize customers to take efficiency and electrification steps and to fund the work necessary for the Utilities to run the programs and contractors to do the work. Ms. Miller argued that current heat pump incentives are inadequate to affect consumer behavior. NJ 50x30 and Mr. Winka noted that the Utilities offer ASHP incentives ranging from $600 to $1000 while the Mass Save program offers rebates up to $10,000 ($1,250 per ton) and the Conn Energize program offers rebates up to $15,000 ($1,000 per ton). Similarly, Mr. Erickson recommended a large increase in cold climate heat pump rebates by all electric Utilities, arguing that the current levels (estimated at less than 15% of installed cost and much lower compared to Massachusetts, Connecticut, and New York levels) are insufficient to swing any decision. Mr. Erickson also called for larger incentives for electric heat pump water heaters, electric heat pump clothes dryers, and induction ranges.

NJ 50x30 asserted that Atlantic City Electric Company ("ACE"), Public Service Electric and Gas Company ("PSE&G"), and Rockland Electric Company ("RECO") do not offer GSHP incentives, while Jersey Central Power and Light Company ("JCP&L") offers a mere $1,500 GSHP rebate.

Additionally, NJ 50x30 called for strong incentives for multifamily electrification, skewed based on income and geography; free audits; continuation of insulation and Energy Star window and door replacements; and strong deployment measurement programs

NJ 50x30, Mr. Erickson, and Ms. Miller recommended incentives for electrical upgrades and panel work. More specifically, NJ 50x30 and Mr. Erickson recommended a substantial electric panel upgrade rebate for 100 amp to 200+ amp panel upgrades, with NJ 50x30 noting that these should take into account electrical upgrades for future needs (e.g., more EV charging, other electric heat pump appliances, induction stoves) and include meter and down lead if needed; discontinuation of all natural gas or propane HVAC and appliance rebates; discontinuation of "free" gas service line installation costs and new gas installations; additional funding from the commercial gas rate base to support increased electrification rebates;

Additionally, Mr. Erickson recommended ensuring 100% clean electricity by 2035 and sufficient grid reliability, capacity, and backup electric storage to handle peak electric loads in summer and winter.

Response: Staff emphasizes that the intent of the Triennium 2 framework is to ensure Statewide alignment of Utility core programs such that EE programs are available Statewide but offered separately by each Utility. Staff appreciates the recommendation for the Utilities' whole home program to advance zero energy home retrofits. Staff also appreciates specific suggestions to prioritize and incentive accordingly specific measures, including cold-climate heat pumps, heat pump water heaters and clothes dryers, induction stoves, geothermal heat pumps, smart panels, panel upgrades, and building shell upgrades, including duct and envelope sealing. Staff understands the call for specific listings of ASHP and GSHP incentives and will work with the Utilities to post these publicly. Staff notes that RECO offers GSHPs

incentives as part of its Clean Heat Pilot program and that this program is helping to inform the design of Staff's forthcoming straw proposal for building decarbonization start-up programs. Staff also appreciates the suggestions to more opportunistically target the beneficiaries of the programs, including LMI and other underserved customers, through tactics such as bundling measures and strategically timing upgrades. These suggestions will be helpful to Staff, the Utilities, and other stakeholders when reviewing Utility program proposals and further refining the details of these programs.
In particular, Staff plans to foster more dialogue with stakeholders about the Utilities' proposals to inform the Board's filing review process that will occur between October 2023 and May 2024. Staff notes that all of the Utilities will have public hearings regarding their Triennium 2 proposed programs, which are open to all stakeholders, and suggests that these are important fora through which stakeholders can provide feedback to the Utilities and Staff about program details. In particular, Staff will work with the Utilities to plan how best to use these public hearings, which may include presentations designed to benefit stakeholders and more actively invite feedback.

Residential: LMI and Overburdened Communities ("OBC"s)

Comments: Rate Counsel expressed appreciation for Staff's focus on ensuring that LMI customers are offered enhanced opportunities and rebates to participate in Utility and State EE programs and lower their energy bills. Rate Counsel also noted that the New Jersey Cost Test ("NJCT") and quantitative performance indicators ("QPIs") should be structured so that the Utilities are not penalized for aggressively serving LMI customers.

Rate Counsel stated that it is imperative that LMI customers should not experience undue additional burdens on their participation in EE programs, such as extensive income verification requirements. For example, EE program application processes should be streamlined so that ratepayers can be considered for multiple programs, if applicable. Rate Counsel stated that the primary eligibility criterion should continue to be household income relative to established standards but also characterized as appropriate the current system of requiring only self-attestation of income eligibility for customers who reside in LMI census tracts or overburdened communities.

Rate Counsel also stated its shared concern with Staff that lower-income tenants could be harmed if Utility-funded EE improvements to their residences prompt landlords to increase rent but noted that it is unclear how even a reasonable restriction that could be an appropriate balancing of interests – such as asking landlords in LMI and overburdened communities to commit to increasing rents by no more than an applicable inflation index for three to five years as a condition of receiving rebates – could be enforced.

NJUA noted the Utilities' belief that streamlining enrollment for LMI customers can make it easier to engage these customers and reduce the administrative efforts to deliver the programs. The Utilities suggested that the enhanced benefits offered to LMI customers could also automatically apply to anyone residing in OBCs.

EEA-NJ emphasized the importance of best serving disadvantaged customers and meaningfully addressing energy burden by ensuring that eligibility criteria do not unnecessarily restrict or create barriers for participation in LMI programs. To this end, EEA-NJ recommended, in appropriate cases, allowing for the use of multiple data sets to identify energy burden, including federal poverty guidelines, area median income, census tract data, OBC designations, and other criteria.

Ceres noted that it was pleased to see the Board's continued interest in learning how to better served disadvantaged communities and low-income residents. Ceres commented that modernizing and expanding the reach of public engagement and education techniques will produce more equitable programs and can incorporate more behavioral solutions for general energy optimization. Ceres provided examples including offering workshops and webinars after 6 pm, providing additional personnel to serve low-income customers, regularly reassessing call scripts and providing them for stakeholder feedback, hosting focus groups and working with community-based organizations on existing support and educational material available to customers to obtain feedback on programs, offering public engagement opportunities through bilingual and bicultural human translators for written and oral communications, and using data and proactive communications to better identify, serve, and provide eligibility and application information to limited-income customers.

Ceres also stated that enhanced data sharing agreements between Utilities, State agencies, and program implementers are crucial to ensuring that benefits reach low-income customers by enabling outreach to more customers in need, mitigating barriers to access, and supporting the customer experience while ensuring data privacy and customer protection.

Regarding EE trade allies and contractors, including business owners and skilled workers, Ceres asserted that information about state and national requirements and guidelines regarding such topics as equity and fair skilled-worker compensation should be made easily accessible, including through after-business-hour public meetings and webinars.

Response: Staff appreciates Rate Counsel's support for the current system of enhanced incentives and financing terms for LMI customers, as well as for the approach to eligibility that is based on location of primary residence and self-attestation of income. In Triennium 1, the Utilities utilized the geographic-based approach to eligibility for customers residing in LMI census tracts; the Utilities also streamlined the eligibility process for customers who receive benefits from an automatic qualifying program based on income.

Staff appreciates Rate Counsel's and the Utilities' support to expand these equity approaches in Triennium 2 by offering enhanced benefits to LMI and OBC customers (i.e., including by allowing for eligibility based on location of residence and self-attestation of income) and including in the QPIs a 10% weighting for lifetime energy savings achieved by LMI and OBC customers.

Regarding EEA-NJ's recommendation, Staff agrees and notes that the current set of programs are already intended to accommodate multiple sources of income data to determine income eligibility by including: 1) federal poverty guidelines (Comfort Partners and Moderate-Income Weatherization programs); 2) census tract data (additional geographic-based approach to eligibility for Comfort Partners and Moderate-Income Weatherization; 3) OBC designations based on census block data (recommended for Triennium 2 as another additional geographic-based approach to eligibility for Moderate-Income Weatherization); and 4) participation in other automatic qualifying programs based on income. Staff also acknowledges that the Utility programs may further evolve along with plans develop to implement the Inflation Reduction Act efficiency and electrification rebates, which are anticipated to be based on area median income.

While Staff is not aware of a way to ensure that LMI and OBC customers do not experience rent increases as a direct result of EE improvements, Staff instead recommends that Utility residential and multifamily programs seek to provide benefits to tenants by offering no-cost and low-cost actions or improvements and through strategies that may include educating building owners about the multiple benefits of EE improvements and providing enhanced incentives and financing terms when building owners undertake EE improvements that benefit LMI or OBC tenants.

Staff thanks Ceres for the suggestions about how to modernize and expand the reach of public engagement and education techniques so as to produce more equitable programs. Staff will keep these in mind as Staff continues to explore how to expand opportunities for stakeholder engagement moving forward.

Residential: Comfort Partners

Comments: Regarding Staff's proposal that the Utilities assume full responsibility for the Comfort Partners program, Rate Counsel expressed concern that the Board could relinquish control over a program that serves ratepayers who are of the greatest need and who generally have the highest barriers to participation in EE programs. Rate Counsel also expressed concern about adding a full Utility return on equity ("ROE") on the cost of the program for the first time. On the other hand, Rate Counsel noted that it sees a potential benefit of coordinating Comfort Partners with other Utility programs, such as moderate-income weatherization, and reducing the potential for customer confusion. Rate Counsel noted that coordinating with other New Jersey agencies is key to addressing health and safety measures that often must be completed prior to weatherization through Comfort Partners. Rate Counsel stated that it would like to see evidence that the cost savings associated with increased administrative and marketing efficiencies would more than outweigh the additional cost of Utility profits associated with the program. Also, if the transfer is permitted, Rate Counsel called for specific policies that would prevent the Utilities from shifting funds out of the Comfort Partners program to other programs.

On behalf of the Utilities, NJUA commended Staff on the proposal to move Comfort Partners to Utility management and expressed commitment to working with Staff and stakeholders to continually increase access to energy savings opportunities for low-income customers. The Utilities expressed their belief that there is a significant advantage to combining Comfort Partners and the extremely similar Moderate-Income Weatherization program. Namely, the Utilities would simplify the customer journey for LMI customers by providing a single point of entry to EE programs and assisting them in finding the best, lowest-cost opportunities for which they are eligible, thereby removing barriers to adoption of EE by these customers. The

Utilities stated that this streamlined pathway will create administrative efficiencies, streamline marketing and messaging, and make it easier to engage with community partners and potentially leverage federal funding. The Utilities also noted the current disconnect between the responsibility for the Comfort Partners budget, which was under the State's control through an annual Comfort Partners budget approval, and the energy savings attributable to the program, which were included in the assessment of energy savings by Utility programs in Triennium 1.

PSE&G expressed appreciation for Staff's proposal to move Comfort Partners to be a fully Utility-administered program, arguing that it aligns with the State's objectives to better serve low-income customers with comprehensive EE options, would place both the budgetary and savings responsibilities with the Utilities, and would allow the Utilities to provide comprehensive options to all residential customers through a streamlined experience.

NEEP noted the importance of ensuring adequate funding and programming for both LMI participants. NEEP also noted that segmenting LMI programs would allow for better coordination by breaking down programs by goals and sector served.

EEA-NJ asserted that Utility-run Comfort Partners programs delivered in coordination with the Utilities' moderate-income weatherization programs would present a great opportunity to create a one-stop shop for customers and contractors, provide benefits to program participants such as avoiding "eligibility cliffs," and simplify administration and application. At the same time, EEA-NJ recommended that Comfort Partners and moderate-income weatherization programs remain distinct and separate to ensure that Comfort Partners' focus and funding remains dedicated to serving low-income residents. Finally, EEA-NJ recommended that Utilities with overlapping service territories should continue to coordinate with each other and BPU on Comfort Partners budgets and services regarding stacking of federal funding, coordination with other State programs, and fulfillment of EO 316 in the most efficient, effective, and streamlined way possible.

Ceres commented that streamlining program information and administration will help reduce customer confusion and increase program enrollment. More specifically, Ceres expressed support for incorporating Comfort Partners into the Utilities' program portfolios to better streamline program access for New Jersey's underserved residents. Ceres also expressed interest in hearing more about the possibility of incorporating Comfort Partners with the New Jersey Department of Community Affairs' Weatherization Assistance Program rather than the moderate-income weatherization program to reduce possible eligibility confusion. Ceres also expressed interest in hearing other stakeholder feedback on ways to make njcleanenergy.com more engaging and accessible.

Franklin Energy commented that, in its experience, programs are most successful when they are utility-led and feature an integrated, customer-centered, and contractor-focused experience with services that coordinate all behind-the-meter offerings. Franklin Energy expressed support for the transition of Comfort Partners to the Utilities because it will create a one-stop-shop for customers and contractors under the Utility-administered umbrella.

Mr. Winka recommended that the Comfort Partners program, as well as the Whole House Pilot program, should include coordinated and integrated delivery of whole building EE upgrades, including shell measures, heat pump appliances, induction stoves, EVs and charging, solar with storage or community solar, and grid interactive building technologies. Mr. Winka also asserted that the Board should directly manage Comfort Partners because of the Utilities' building electrification conflict of interest.

Response: Staff acknowledges that the Utilities have been, for many years, managing Comfort Partners based on their budgets and implementing the program in their territories on a day-to-day basis with Board oversight. One of the purposes of Staff's proposal to allow the Utilities to propose to include Comfort Partners in Utility EE portfolios is to align the Utilities' responsibility for both the budgeting and energy savings pertaining to the program. Staff also views the potential benefits of coordinating Comfort Partners with the Utilities' moderate-income weatherization programs, as noted by multiple commenters, and shares Rate Counsel's interest in seeing evidence that the cost savings associated with increased administrative and marketing efficiencies would more than outweigh the additional costs associated with including the program in Utility portfolios.

Staff also appreciates and agrees with the calls for Comfort Partners to remain a strong focus within New Jersey's EE programs in concentrating on low-income customers and ensuring that they receive the benefits of EE. Staff is interested in specific carve-outs and protections for Comfort Partners budgets – for example, by permitting Utilities to increase designated funding for Comfort Partners as needed but not reduce funding for the program within the triennium.

Multifamily

Comments: EEA-NJ recommended that the Board ensure that "incentives for whole building EE and electrification solutions" are included across multifamily programs as proposed for residential and C&I programs.

MaGrann encouraged clarification that the inclusion of incentives for whole building electrification solutions under the residential and commercial and industrial ("C&I") Utility core programs will be available for multifamily properties.

Response: Staff thanks EEA-NJ and MaGrann for bringing attention to this and notes that Staff's final recommendations clarify that multifamily programs should provide program offerings comparable to those available to residential customers, notably, incentives for whole home and building EE and electrification solutions, including solutions that generate deep, long-lasting, and cost-effective energy savings.

C&I

Comments: TSLE urged the Board to remove the hurdle of the public bid requirement for Utility programs, as they prohibit many public customers from participating in the programs.

Response: Staff appreciates the importance of the comment and notes that Staff from multiple BPU divisions and the Division of Law have been working throughout this triennium with the New Jersey Department of Community Affairs' Division of Local Government Services and Utilities to understand and address barriers to participation by public entities (most notably, public schools and local, county, and State government) in Utility programs. Staff is pursuing solutions that have the potential to work within the one (1) year remaining in the current triennium. For Triennium 2, Staff has recommended that the Utilities offer public sector program pathways specifically designed to meet the unique needs of and requirements associated with public sector customers and work with Staff to address any barriers to participation by these customers.

ii. Additional Utility Initiatives

Comment: Franklin Energy argued that EE, building electrification, and demand management solutions should be deployed in an integrated fashion under a single set of program administrators. For example, Franklin Energy argued that homeowners benefit from a simplified enrollment process through a one-stop-shop model that gives customers one place to educate themselves on program offerings, check qualifications, submit for rebates, and schedule installations.

TSLE stated that the Utilities should be directed to run pilots for decarbonization and demand response ("DR") immediately.

Response: Staff appreciates the recommendation for integrated, coordinated program administration of multiple initiatives, including toward the end of streamlining processes for customers.

Decarbonization Start-Up Programs

Comments: PSE&G expressed support for the proposal to include a decarbonization start-up program as part of the EE framework, calling the installation of energy efficient equipment for the decarbonization of buildings and equipment an important step toward achieving the mandates set forth in EO 316 and the goals of the CEA.

NEEP offered some recommendations on the decarbonization start-up programs, while acknowledging that there will be more information to come from Staff. It recommended a Statewide definition for weatherization, creating scalable weatherization programs, including consumer education, ensuring quality performance and installation, and incorporating grid flexibility measures.

NRDC asserted that the Triennium 2 programs should have as their core goal the rapid decarbonization of the building sector by maximizing beneficial building electrification and decreasing energy costs for New Jersey consumers, especially LMI consumers, in alignment with the State's economy-wide climate goals and related efforts [e.g., wind, solar, EVs, future of gas proceeding, distribution planning, data access] and Inflation Reduction Act ("IRA") funding and through a robust, inclusive, and comprehensive stakeholder process that helps to determine the goals, objectives, program guidance, and requirements of the Triennium 2 programs.

In addition to Mr. Winka's more general comments about integrating clean energy programs, increasing ASHP incentives, providing centralized information about electrification technologies and incentives, and setting building electrification goals (all of which are addressed in other sections), Mr. Winka also specifically suggested including solar thermal heating in the building electrification straw proposal.

Response: Staff appreciates the comments and suggestions and looks forward to further dialogue interested stakeholders about the remaining aspects of the Triennium 2 framework that have yet to be proposed for public comment, including regarding Triennium 2 goals, targets, performance incentives and penalties, building decarbonization start-up programs, and demand response programs.

Demand Response Programs

Comments: PSE&G agreed with Staff's proposal to include DR programs as required EE portfolio elements within the EE framework. PSE&G expressed concern that Staff did not propose including energy storage as an optional demand management resource and argued that the Board should allow the Utilities to integrate energy conservation technologies – specifically, energy storage – and thereby provide more holistic solutions that increase the overall uptake of EE and renewable energy technologies.

NEEP offered some recommendations on the DR framework, while acknowledging that there will be more information to come from Staff. It recommended coordinating with stakeholders to establish statewide data transparency policies, including an educational campaign to inform customers, including time-of-use rates that pay customers to be part of the grid, and incentivizing the equitable adoption of smart technologies.

EEA-NJ noted the lack of detail for the DR programs in the initial straw, appreciated BPU's recognition of this fact, stated that it looks forward to BPU's additional stakeholder progress on the topic, and commented that the process should provide directives on how participation and coordination should be established prior to the Utility filings. EEA-NJ offered its recommendation for including communication pathways for wi-fi devices to participate in demand response both with and without AMI. EEA-NJ suggested that DR enrollment can and should happen at the time of a retrofit or when a customer purchases a smart thermostat on a Utility's online marketplace.

Google Nest asserted that there is tremendous untapped potential to enroll hundreds of thousands of New Jersey residents with smart thermostats in paid DR programs and allow them to contribute meaningfully to reducing peak demand during the next triennium. Google Nest offered comments focused on how the Board can lower barriers to participation and drive enrollment in DR programs while retaining existing EE incentives to ensure that efficiency benefits are also captured. First, Google Nest argued that the wide deployment of smart thermostats is critical because they are an affordable solution for millions of households to save energy that otherwise would not have the means to finance and install more expensive distributed energy resources. Second, Google Nest argued that, with the right incentives and program design, smart thermostats could quickly serve as a critical new tool to manage peak demand and reward households for participation. Third, Google Nest recommended that the Board include smart thermostat DR programs, including specific minimum filing requirements ("MFRs") for Utilities' DR programs, as part of Utility core programs rather than as additional Utility-led initiatives so as to provide consistency in design and ensure quick and successful scaling-up across the state.

Google Nest offered specific recommendations for a successful DR program: offer a one-time enrollment payment to customers as well as a smaller, recurring payment for customer retention; encourage pre-enrollment in DR programs at point of sale of smart thermostats; enable stacking of EE and DR incentives; launch smart thermostat DR programs without waiting for AMI deployment because smart thermostats can independently measure runtime data.

Mr. Winka stated that the electric utilities should provide a managed EV charging program that provides an optimal timeframe for charging EVs and a time of use off-peak rate, at a minimum. He also stated that the electric utilities should develop a rate structure that benefits small and medium-sized non-residential electric customers to install battery storage in facilities that have or will install on-site distributive solar systems.

Recurve supported Staff's recommendations encouraging Utilities to leverage the investments in AMI to the fullest extent, noting that AMI is essential to enable consistent and transparent calculation and adjudication of performance payments.

SPAN supported the proposal to include DR as part of Utility initiatives. SPAN noted that, as buildings electrify and further define and accentuate the load peak, DR will become an increasingly important resource to manage peaks, including through facilitation by intelligent, individual circuit control of a smart panel to avoid overloads of the panel and the grid. SPAN recommended that, when a customer purchases a smart panel from a marketplace or installer, the customer should be given the option of pre-enrolling in a DR program.

Uplight appreciated the inclusion of Utility demand response programs in the straw proposal, saying that they represent a large, cost-effective opportunity for generating avoided costs that will save ratepayers money on their bills. Uplight also stated that it would like to see more detailed guidelines to better inform the programs that Utilities propose, including so that customers participate in them and can easily opt-out of events or the program. Uplight suggested that the Board should encourage the Utilities to coordinate DR plans so as to allow for two outcomes from one resource (e.g., DR resource can be used for both summer peak electric reduction and peak gas reduction in the winter).

Response: Staff appreciates the comments and suggestions and looks forward to further dialogue in response to the forthcoming straw proposal on this topic.

iii. Consistency in Program Elements and Design Standards

Comments: Rate Counsel expressed appreciation for attention to this goal, noted that it has been an important element of the success of New Jersey's reorganized

EE service delivery paradigm, and called for the Utilities, Staff, and all other stakeholders to continue to share best practices and experience through the various working groups to further standardize and improve EE service delivery throughout the state. Rate Counsel also recommended joint Utility filings for core programs in future triennia to ensure Utility coordination and similar experiences with programs among ratepayers, as well as to streamline the Board's approval process for EE programs.

NJUA noted that the Utilities have invested significant time and effort over the past few years to strive for a balance of coordination on the programs without sacrificing the ability to recognize and address unique elements within their service territories. The Utilities intend to continue to coordinate program design and delivery but cautioned moderation in requiring all elements to be consistent.

Franklin Energy suggested that targeted marketing campaigns focused on educating consumers and contractors, including diverse contractors in disadvantaged communities that help them capitalize on rebate programs and maximize benefits are necessary to generate greater awareness of the programs and increase levels of enrollment and adoption.

Franklin Energy also commented that the Utilities should be able to reach customers and present offers that vary by their differing customer bases. More specifically, Franklin Energy recommended that the Utilities should continue to be in constant communication but also have the flexibility to pivot when necessary so that program performance data can inform decisions to adjust incentive levels or go-to-market strategies.

SPAN encouraged the Board to adopt a consistent program design and coordinate marketing for common incentives across New Jersey, so as to avoid customer confusion and reduce marketing costs. For example, SPAN suggested that the Utilities could run a consolidated marketplace that aligns program structures and incentives; provides customers with a one-stop-shop to understand incentives, purchase products, and schedule installations; and includes benefits for LMI customers.

Ms. Miller supported consistency among Utilities in consumer process, upgrade recommendations, and incentive amounts; recommended training for contractors/trade allies and dealers about guidelines for recommendations, design and sizing, incentives, and stocking related to electric heat pump appliances; suggested a comprehensive marketing and education effort for consumers about the advantages of clean energy. Similarly, Mr. Winka stated that the Board should require all utilities to provide outreach and education related to building electrification options through marketing, including cold climate heat pumps; provide an independent, centralized, and detailed information program on heat pumps technologies, costs and benefits, incentives, and financing. NJ 50x30 also stated that the Board should make available through a centralized website information on heat pump details, incentives around the state, and how to find a contractor (using contractor-specific criteria such as number of processed rebates), as well as a calculator and information on financing. NJ 50x30 also recommended that the gas

Utilities should provide information on cold climate heat pumps to anyone pursuing a new high-efficiency furnace or boiler rebate.

NJ 50x30 and Ms. Miller also called for program design to be exactly the same among all of the Utilities, including process for consumers, recommendations for upgrades, and incentive dollar amounts.

Response: Staff acknowledges the ongoing efforts of the joint Utilities to coordinate and collaborate on program design and delivery and agrees with multiple commenters about the goal of continuing to strive to improve participation by and experiences of customers' throughout the State.

iv. Budgeting Based on Commitments

Comments: NJUA urged the Board to include language in the Triennium 2 framework order directing all Utilities to develop program plans and budgets based on project commitments, consistent with the approach that NJCEP and the Utilities have used in the past, to simplify the process of budget coordination. NJUA also noted that the Utilities plan to work closely in planning Triennium 2 budgets and will work to allocate budgets in overlapping territories in coordination with partner utilities with the goal of accommodating all lead/partner project requests. At the same time, NJUA cautioned that overlapping territory budgets cannot be considered final at any point given changing participation trends and should be viewed as directional while allowing the Utilities flexibility in actual budget implementation.

Response: Staff agrees with NJUA's suggestion.

v. Joint Utility Coordination

Comments: Rate Counsel noted that coordination among Utilities in budgeting for program delivery in overlapping Utility service territories was not successful in Triennium 1 and should not be repeated. Rate Counsel recommended more specific requirements for the Utilities, which could include Utilities in overlapping territories filing joint budgets for each program. Rate Counsel also called for the Utilities to provide detail in their filings regarding the Statewide Coordinator, including software and activities to be performed under contract, and argued that the Statewide Coordinator should have independent oversight of budget inputs and alert Utilities of risks of budget mismatches.

MaGrann agreed that there is a need for more successful coordination and consistent delivery among the Utilities. MaGrann suggested that, in addition to the points identified in the straw proposal, efforts could be made to ensure that coordination between programs within the same Utility (or between joint Utilities) is leveraged to maximize participation and savings on a total project basis. For example, active collaboration and cross training between programs could lead to additional and more comprehensive solutions that ensure that all project opportunities are identified and realized, during intake and site assessment processes.

Response: After consideration of Rate Counsel's suggestion, Staff has adjusted its recommendation to indicate that the Utilities should continue to jointly engage a Statewide Coordinator system to facilitate the exchange of information and coordinate implementation of programs in overlapping Utility territories by Lead and Partner Utilities. Also, Staff recommends that Utilities continue to jointly plan and coordinate budgets in overlapping Utility territories, with support from the Statewide Coordinator system as appropriate, as well as to work cooperatively to identify and address budget constraints between the Utilities through the Joint Budget Allocation Committee (which has been established to monitor and manage program budget coordination among the Utilities) and as set forth in the Utilities' bilateral Memoranda of Agreement.

Staff appreciates MaGrann's suggestion to increase collaboration and cross-pollination among programs and will keep this in mind when reviewing the details of the Utility's program proposals.

vi. Flexibility

Comments: Rate Counsel expressed its position that the parameters for budget shifting within and among sectors in Triennium 1 struck an appropriate balance between flexibility and accountability but, given the differences of opinion on this balance and the work that went into reconciling them, Rate Counsel expressed support for Staff's related proposals. Rate Counsel proposed specific alternative language to address instances where a Utility program is at risk of being shut down due to the budget being exhausted.

EEA-NJ and TSLE expressed support for the tiered structure for Utility budget adjustments designed to provide appropriate flexibility and recommended including clarification that the shifts in budgets are to be "once per 365-day period."

Response: In response to Rate Counsel's suggested language, Staff's recommendations include edits to the footnote regarding budget shut downs to require 30 days' notification or as soon as possible in the event of exigent circumstances.

Regarding EEA-NJ's and TSLE's suggested language, Staff notes that the language was written intentionally to allow a Utility to shift budgets one or more times up to and including 25% or 10% of its total triennium budget (as applicable to shifts within the same sector or out of a sector, respectively) within any 365-day period of time.

C. State-Led Programs and Initiatives

Comments: PSE&G stated its belief that there are benefits to having all EE programs, including new construction and large energy user programs, offered through Utilities to minimize customer confusion, streamline administration, and leverage the benefits of Utility administration.

Aeroseal recommended incentivizing construction of high-performance and net-zero buildings and noted that such an approach could be especially effective in reducing energy burden and creating healthier, safer, and more comfortable living spaces in affordable housing.

NJ 50x30 and Mr.Winka recommended that the Board establish funding for and manage zero energy homes programs, including one specifically for affordable homes in coordination with the New Jersey Department of Community Affairs, that provide incentives to build a new home, including heat pump appliances, EV charging, and solar with storage. Mr. Winka noted additional technologies that should be included – induction stoves, electric panel upgrades, and grid interactive building technologies – and that the zero energy homes program for new homes should use Universal Service Funds. NJ 50x30 called for additional incentives for new construction built to super-efficient, passive house standards, which reduce energy up to 80% in a building compared to conventional construction.

Mr. Winka also commented that the Utilities and Board should detail specific initiatives in addition to the "Quantification of energy savings from building energy codes," such as outreach and education to increase support to adopt zero energy building codes.

Response: The BPU has, and will, continue to manage a new construction program that provides financial incentives for high-performance new buildings, including net zero / zero energy buildings, passive homes, and special considerations for affordable housing. Staff understands and appreciates PSE&G's comment and notes that the next triennial review can include discussion about future administration of EE programs.

In addition, Staff agrees that the State should assess the energy savings that result from building energy codes and appliance standards initiatives. The State's recently engaged EE Evaluation Study Team has been assessing energy savings for Triennium 2 from New Jersey's appliance standards law. Regarding building energy codes, the Rutgers Center for Green Building has been assessing energy savings for Triennium 2 from New Jersey's building energy codes. Moreover, Staff's recommendation for a State program to quantify energy savings from building energy codes could be accompanied by State-led strategies to increase energy savings through greater code compliance, such as through enhancing and improving training for the architecture, engineering, and construction community and local code officials.

D. Workforce Development

Comments: NJUA expressed support for Staff's proposed approach to coordinated delivery of workforce development initiatives and stated that the Utilities look forward to continuing to collaborate with Staff and other stakeholders on these efforts. NJUA commented that it is critical for wrap-around services to be established and delivered comprehensively throughout the state to ensure that local underrepresented, and disadvantaged residents have the opportunity to participate in training programs that can help launch clean energy careers.

PSE&G also expressed support for Staff's proposed approach to workforce development, noting its belief that the approach will align with PSE&G's Clean Energy Jobs Program, describing the success of that program, and stating that PSE&G looks forward to continuing to support the growth of New Jersey's clean energy industry in Triennium 2.

Dandelion asserted that workforce programs are critically important and should receive significant funding and attention to meet workforce shortfalls in heat pump installations, including through examination of existing licensing barriers.

NEEP first recommended creating a Statewide workforce plan that could establish existing resources and goals to grow and sustain an EE and building decarbonization workforce and establish standards that ensure state and/or regional consistency. Such a plan could also include a stakeholder engagement process that allows residents, community organizations, local businesses, and utilities/program implementers to identify opportunities and needs, map existing resources, and identify ways to coordinate them. Second, NEEP recommended an online contractor-led certification for whole home energy retrofits and noted that NEEP is working to create a Total Energy Pathways Certificate program, funded by the U.S. Department of Energy, to train contractors about how to deliver whole home retrofit projects and offer Building Performance Institute certificates upon completion of the training. Third, NEEP recommended equity-centered tracking metrics to help set appropriate and achievable equity-related goals and track program implementation to allow for adjustments, citing as examples the number of workers trained, certified, and placed in jobs. NEEP offered its *Identifying Equity Centered Tracking Metrics* report as a resource. Fourth, NEEP recommended establishing minimum requirements for heat pump specifications, contractor certifications, and insulation requirements to ensure quality installation and performance. NEEP offered multiple resources on this topic as well.

Response: Staff appreciates the support for workforce programs and Staff's proposed approach. Staff also thanks NEEP for the recommendations and resources on workforce development. Regarding a Statewide workforce plan, Staff notes that Governor Murphy's Council on the Green Economy delivered a *Green Jobs for a Sustainable Future* report (September 2022) that describes the current landscape of green jobs in the state, assesses green job potential, and provides strategic recommendations to make future green job growth transformative for New Jersey's economy, including 2030 goals and a 12-month action plan. On a related note regarding Statewide resources and coordination, the 2019 EMP (Goal 7.6) called for New Jersey to explore establishing a Clean Buildings Hub to develop workforce training, awareness, and education for builders, architects, contractors, engineers, real estate agents, and code enforcers in the most efficient electrification, construction, and retrofit building techniques. Staff is currently exploring BPU's potential role in establishing and supporting this hub with partners including other State agencies, the Rutgers Center for Green Building, the New Jersey Institute of Technology's Clean Energy Learning Center, and others.

E. Coordination Between Utility-Led and State-Led Programs

Comments: Staff received no specific comments on this topic.

II. PROGRAM FUNDING

Comments: Rate Counsel stated its belief that the IRA creates increased opportunities for Utilities and the Board to seek out federal funding for EE programs and expressed its hope to continue to work with the Board and Utilities to learn of opportunities to maximize federal funding and reduce the amount that ratepayers pay for EE programs.

NJUA expressed support for the inclusion of language related to potential program modifications in order to leverage other funding opportunities, such as through the IRA, to complement the Utility EE programs but also advocated for additional program modifications to be collaboratively developed and discussed thoroughly given potential impacts to other elements of the Utility programs, such as goals, QPI targets, and cost-effectiveness.

NEEP noted that, by identifying ways to braid funding for LMI programs, BPU and the Utilities can implement initiatives to braid low-income incentives with other available state and federal funding.

Aeroseal noted that BPU can direct Utilities to use IRA funding to complement Utility programs and advance high-impact strategic measures such as duct sealing or heat pumps. Aeroseal commented that the BPU and Utilities will play an important role in ensuring that these measures are effectively layered to reduce up-front and operating costs for residents.

SPAN strongly encouraged New Jersey to commit to allowing IRA incentives to stack with Utility EE incentives and to expeditiously determine how Utilities and implementers can ensure that customers can take advantage of the stacked incentives with minimal friction once federal guidance is available. SPAN suggested that a uniform online system or interface should be developed to enable installers to access state and federal rebates and to facilitate customers to learn about programs, determine income eligibility, sign up for rebates, and schedule installers. SPAN also noted that income qualification requirements among federal and state programs (including Comfort Partners) should be aligned to minimize customer confusion.

NJ 50x30, Mr. Erickson, Ms. Miller, and Mr. Winka asserted that the BPU should provide IRA incentives in addition to, not as a replacement of and with no reduction in, Utility EE/PDR incentives, in a streamlined way for customers. Ms. Miller also noted that, since many non-LMI customers will not receive IRA rebates, the State should ensure that they have sufficient incentives to transition to electrification. Further, Ms. Miller noted that, while IRA includes some annual maximum incentives amounts that may require customers to stage upgrades over multiple years, state incentives should not require this staging.

Response: Staff agrees that the State and Utilities should explore and pursue additional federal and state funding to support and complement New Jersey's existing EE programs and defray burdens on ratepayers. Regarding federal funding, BPU, as New Jersey's State Energy Office, is charged with applying for, receiving, and implementing IRA rebate funding. Staff therefore proposed in the first Triennium 2 framework straw that Staff would work with Utility and State program administrators and Rate Counsel to determine how to most efficiently and effectively leverage additional funding from the U.S. Department of Energy, including IRA efficiency and electrification rebates, to maximize the benefits of existing programs. Staff looks forward to continuing to work with the Utilities, Rate Counsel, and stakeholders to maximize federal funding to support and enhance existing EE programs, including in ways that provide further benefits to ratepayers and streamline participation by businesses and customers. This will include considerations for how to deliver rebates to LMI and non-LMI customers, as applicable, as well as for how to ensure that non-LMI customers are aware of tax credits for which they are eligible.

Regarding State funding, Staff has been coordinating discussions with the New Jersey Department of Labor, Utilities, and other members of the EE Workforce Development Working group toward the end of establishing State grants for eligible participants from New Jersey's

OBCs to receive core employment and training services (including wrap-around supportive services) and intensive employment and training services (including on-the-job training placements with employers). These State grants would complement Utility-funded initiatives (including subsidized or no-cost training programs for workers to gain credentials, including certifications, for EE and decarbonization jobs). Staff therefore proposed this approach in the first Triennium 2 framework straw and continues to recommend this approach.

III. GOALS, TARGETS, PERFORMANCE INCENTIVE MECHANISM (RESERVED)

Comments: NJUA urged the Board to consider developing a method for allowing the Utilities to bank or carryover excess energy savings achieved in one year and allowing that savings to be applied to the compliance goal for future program years. NJUA advocated for this approach in order to address risks of variable program performance and energy savings from year to year and to promote the benefits of the earliest attainment of energy savings.

Uplight noted that there a number of metrics that should be begin to be tracked related to additional State goals on clean energy targets and carbon savings. Uplight recommended the following potential metrics: annual GHG reductions across the portfolio, programs, measures; total GHG reductions across the portfolio, programs, measures; present value of damages avoided from GHG reductions; dollars per ton of reduction in GHG reductions; kilowatt-hours saved during peak demand hours; GHG saved during peak demand hours; additional renewable energy enabled by demand side solutions; program enrollments from other programs (i.e., cross promotion); and number of customers enrolled in 1, 2, 3, etc. programs.

Mr. Erickson recommended strong residential, commercial, and vehicle electrification goals and measure programs, by each type of equipment and transportation mode, with annual objectives set for each, along with mandatory, strong annual EE reduction objectives for natural gas, propane, oil, and resistance electric heat.

NJ 50x30 and Mr. Winka recommended setting an annual goal for heat pump installations based on EO 316. NJ 50x30 noted that this goal should be increased if the State adopts a decarbonization law or the Clean Buildings Working Group establishes a higher goal. Mr. Winka emphasized the need to meet the State’s goal of achieving a 50% reduction in 2006 GHG emissions by 2030.

Response: Staff thanks NJUA, Uplight, NJ 50x30, Mr. Erickson, and Mr. Winka for the initial comments and looks forward to continued feedback after Staff shares a proposal on this topic.

IV. FILING REQUIREMENTS

A. Utility Program Filings

Comments: NJUA requested that the Board approve Utility filings by April 1, 2024 in order to allow for contracting efforts to be completed and to minimize disruptions in the market. NJUA also noted that some newer efforts (e.g., potential demand response programs) may not be available at the start of Triennium 2 and that each Utility will reference any timing considerations regarding the launch of newer programs as part of their implementation plans.

PSE&G also expressed concern about the proposed timeframe for Board action on Utility filings by June 1, 2024 and suggested that Board action by April 1, 2024 would allow the Utilities to plan for and implement the programs by July 1, 2024. In particular, PSE&G noted that it may not be possible to complete all necessary contracting updates between June 1 and July 1 so as to ensure continuity of EE programs and that trade allies and contractors require time to adequately resource their organizations to build on the momentum from Triennium 1.

Franklin Energy expressed concern than any procedural delays in Board approvals of Utility programs could result in market disruption and delays in program implementation. Franklin Energy called for coordination regarding the procedural schedule and an expedited proceeding to allow for the programs to from without gaps.

NJ 50x30 called for the Utilities to file as one entity in one filing under one proceeding instead of inefficiently through seven (7) different filings and proceedings.

Response: Staff notes that the straw proposal did not reflect the fact that the energy year begins on June 1 and, therefore, the CEA requires the Board to act on Utility filings 30 days prior to June 1, i.e., by May 1. Staff has revised its recommendation such that Utilities would file by October 2, 2023 and that Board action would occur by May 1, 2024. The Utilities may also request an extension of time on the filing deadline, which Staff will review on a case-by-case basis.

Staff appreciates the desire for a single Utility filing and the benefits of streamlined review by the Board, Rate Counsel, and parties to the filings. Staff's understanding is that it is not feasible to have a single Utility filing because of Utility-specific information, some of which is confidential, that must be submitted. However, toward the end of streamlining the filing and review process, Staff recommended that the Board direct the Utilities to jointly develop a consistent organizational structure with common elements in their filings, to the greatest extent practicable. This will help to facilitate and expedite review by the Board and parties to each of the seven (7) Utility filings, toward the end of program implementation beginning July 1, 2024.

Minimum Filing Requirements ("MFRs")

Comments: Rate Counsel expressed support for most aspects of the proposed MFRs but provided some specific recommended changes:

- Pilot programs should not be automatically exempt from the cost recovery and Evaluation Measurement and Verification ("EM&V") requirements in the MFRs. Rather, Rate Counsel recommended that the Utilities be required to request exemption if desired and suggested that the Board will likely rely on cost recovery and EM&V information when determining whether to approve or continue a pilot program.
- The MFRs should require the Utilities to provide more detailed budget information and accounting for core programs in areas where gas and electric utilities overlap to support the consistent delivery of programs.
- The MFRs should require the Utilities to provide a narrative detailing its plans to seek federal and state funding to all other programs, especially workforce development programs, where funding is available and designed to align with a

specific program. The Utilities should commit to provide their associated accounting plans to offset charges to ratepayers and/or provide ratepayer credit when the Utility receives that funding.

- When submitting supporting documentation associated with cost recovery, the MFRs should provide examples of program cost categories in order to ensure consistency among Utility filings.
- The Utilities should continue to include benefit-cost analyses under all five California Standard Practice Manual benefit-cost tests, as proposed in the straw, to enable the Board to evaluate the cost-effectiveness of the programs from various perspectives.

NJUA expressed appreciation for Staff's updates to the MFRs and Staff's attention to what information should be included for the Utilities' portfolios versus for each individual program. The Utilities suggested that workforce development costs be excluded from benefit-cost testing because workforce initiatives are incredibly important but do not create immediate energy savings; they also noted that this change is consistent with NJCT Working Group discussions. The Utilities also suggested consideration of the exclusion of health and safety costs from benefit-cost testing because they do not directly increase energy savings.

PSE&G expressed general support for the MFR changes but urged the Board to exclude workforce development and health and safety costs from benefit-cost testing. PSE&G also argued that, rather than requiring each Utility to conduct six cost-effectiveness tests, the Board should only require two cost-effectiveness tests to be conducted for Utility filings – the NJCT as the primary test and the Utility Cost Test as a secondary test – because running multiple, similar tests adds no real insight or value to the public or the Board in assessing portfolios. For example, PSE&G noted similarities between the Societal Cost Test, Total Resource Cost Test, and NJCT. PSE&G also asserted that the Rate Impact Measure Test shows that rates will go up but ignores the facts that overall bills will go down customers use less electricity or natural gas.

Response: The proposed MFRs included a typo where the actual intent was to propose that pilot programs would not be subject to benefit-cost analysis and EM&V requirements in the MFRs. After further consideration, Staff recommends that the MFRs state that pilot programs are among the examples of historical situations that have qualified for exemption from the benefit-cost analysis and EM&V sections of the MFRs while not specifically providing that pilot programs will not be per se subject to these sections.

Staff agrees that the Utilities should use consistent program cost categories in their filings. Staff notes that "Section II: Program Description" of the MFRs proposed program cost categories and that "Section IV: Cost Recovery Mechanism" now reference these same cost categories.

After further consideration, including consultation with the Statewide Evaluator, Staff agrees that costs of workforce development initiatives, health and safety measures, and outreach to community-based organizations may be excluded from the NJCT and reported separately.

Staff believes that there continues to be value in requiring the Utilities to include benefit-cost analyses using the NJCT and the five California Standard Practice Manual tests because each includes a different perspective on and represents a different weighing of benefits and costs that are helpful to the Board, Rate Counsel, Statewide Evaluator, and other parties and stakeholders in understanding the cost-effectiveness of proposed programs.

B. State Program Filings

Comments: NJUA commended Staff's recommendation that the State file its NJCEP EE program filings on the same three-year cycle as the Utility EE programs. NJUA also expressed strong support for Staff's proposal to report State program performance on the same schedule as the Utilities, which will allow stakeholders to better understand the State's overall progress toward CEA goals.

Response: Staff appreciates the comment.

C. Utility Annual Compliance Petitions

Comments: RECO requested that the Board clarify and confirm that the Utilities' compliance filings and cost recovery petitions are not filed at the same time. Rather, RECO noted that the Utilities make their cost recovery petitions when they file to true-up their Regional Greenhouse Gas Initiative ("RGGI") surcharge and that these filings occur at different times during the year for each Utility.

Response: Staff appreciates the request and has clarified that the annual compliance filings and annual cost recovery petitions are filed at separate times.

V. COST RECOVERY

A. Program Costs

Comments: RECO commented on Staff's proposal that the Utilities' cost recovery petitions should be consistent with the Cost Recovery section of the MFRs. RECO noted that the Cost Recovery section of the MFRs addresses items to be included in the Utilities' Triennium 2 petitions but that the Utilities' Triennium 1 settlement stipulations include an attachment with the MFRs for the annual cost recovery petition that is significantly different from the Cost Recovery section of the MFRs for Triennium 2.

Response: Staff appreciates the comment and has removed the reference to the Cost Recovery section of the MFRs to clarify that it is not applicable to the cost recovery petitions.

B. Investment Treatment

i. Amortization

Comments: PSE&G expressed concern about the proposed fixed amortization period and stated its belief that it is consistent with rate making best practice is to match the benefits that a program generates as closely as possible with the program amortization period of that investment. PSE&G elaborated that amortizing investments over a fixed, generic 10-year period would break the link between the bill impacts of the program and the benefits that the program generates. PSE&G suggested an amortization period for EE investments that aligns with the weighted average useful life of each Utility's proposed portfolio.

Response: Staff appreciates the suggestion but also wishes to balance alignment of program benefits with the amortization period, on the one hand, with the impacts to ratepayers of paying for these benefits over longer amortization periods. Therefore, Staff continues to recommend that amortization of EE programs not exceed 10 years.

ii. Rate Caps

Comments: Rate Counsel stated its belief that the Board should mandate caps for the cost of the EE programs, especially in light of proposed changes to the NJCT, which Rate Counsel asserted would result in increased costs to ratepayers. Rate Counsel urged the Board to set guardrails for the Utilities that balance ratepayer costs with EE program goals. Rate Counsel proposed a rate cap similar to that which applies to renewable energy, citing the mandate in Electric Discount and Energy Competition Act ("EDECA") at N.J.S.A. 48:3-87(d)(2) that "the [B]oard shall ensure that the cost to customers of the Class I renewable energy requirement imposed pursuant to this subsection shall not exceed nine percent of the total paid for electricity by all customers in the State" for a particular energy year. In short, Rate Counsel argued that the rate cap for EE programs should be capped at no more than 9% of all retail gas and electric rates in each energy year.

Response: Staff understands and appreciates Rate Counsel's concern about capping the rate costs of EE programs. While the EDECA mandate serves as a useful reference, Staff does not recommend applying the EDECA renewable energy mandate to EE programs. In response to Rate Counsel's comments, however, Staff reviewed the gas and electric Utilities' EE rates as a percentage of their overall rates. As shown in the tables below, from January 2021 through April 2023, which includes the transition of many EE programs to the Utilities starting in July 2021, the statewide average for EE rates has been 1.48% of total retail gas rates and 1.07% of total retail electric rates.

Statewide Average - Gas - EE as % of Total Rate													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg/Year**
2021	0.88%	1.14%	1.14%	1.14%	1.14%	1.13%	1.84%	1.84%	1.79%	1.51%	1.51%	1.51%	**1.38%**
2022	1.87%	1.91%	1.85%	1.80%	1.80%	1.79%	1.79%	1.79%	1.74%	1.39%	1.39%	1.39%	**1.71%**
2023	1.24%	1.27%	1.43%	1.42%									**1.34%**
												3-Year Avg.	**1.48%**

Statewide Average - Electric - EE as % of Total Rate													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg/Year
2021	0.85%	0.92%	0.75%	0.74%	0.75%	0.72%	0.96%	0.96%	0.99%	0.96%	0.99%	0.99%	**0.88%**
2022	0.97%	0.99%	0.91%	0.91%	0.97%	0.98%	1.20%	1.20%	1.27%	1.27%	1.27%	1.27%	**1.10%**
2023	1.25%	1.25%	1.23%	1.22%									**1.24%**
												3-Year Avg.	**1.07%**

Staff will evaluate proposed rate increases in the Utilities' Triennium 2 filings. Staff recommends that the Board direct Staff to continue to monitor EE rates as a percentage of overall retail gas and electric rates during Triennium 2 to ensure that EE ratepayer costs remain reasonable and to revisit recommendations for EE rate caps during the triennial review period.

iii. ROE

Comments: Staff received no specific comments on this topic.

C. Lost Revenue Treatment

Comments: EEA-NJ expressed appreciation for Staff's recommended limitation placed on the proposed LRAM, specifically regarding limiting the LRAM calculation of its ROE and disallowing recovery if ROE from the Utility's last base rate case increases by 50 basis points or more, as well requiring a base rate case filing no later than five years after the commencement of an approved EE program. EEA-NJ also opined that the CIP "is an improvement over the LRAM as it provides incentive payments for participating in EE programs; however, unlike LRAM cost recovery, CIP incentives scale upwards as utilities invest more in energy efficiency. While the incentive to sell more energy and make more revenue still exists, there is now a counter incentive to maximize energy efficiency and CIP incentives." In conclusion, EEA-NJ expressed its belief that New Jersey should institute full symmetrical decoupling and that Board should state the Utilities can and should file plans that incorporate decoupling. EEA-NJ asserted, "Full symmetrical decoupling would guarantee utilities a fixed revenue determined in a base rate case; the process is similar to standard rate proceedings, with the addition of a responsive mechanism that controls utilities' revenue streams. The mechanisms would leave utilities indifferent to energy usage and would focus their profit-making activities on cost savings and meeting minimum performance standards, including those for energy efficiency."

NJ 50x30 recommended that the Board shift from a focus on energy throughput to include the cost of GHG emissions and reward GHG reduction. More specifically, NJ 50x30 called for revisions to the following: the Utilities' EE and PDR budgets to reward efficiencies and GHG reductions; the Societal Benefits Charge ("SBC") to reflect GHG reductions; the lost revenue adjustment mechanism ("LRAM") to incorporate the cost of GHG emissions and savings due to emissions reductions; and the Conservation Incentive Program ("CIP") to use GHG emissions reductions as the benchmark indicator. NJ 50x30 argued that this approach would ensure consistency with the CEA, EMP, New Jersey Department of Environmental Protection's *GWRA 80x50 Report,* and Executive Orders 275, 315, 316, and 317.

Similarly, Mr. Winka recommended that, to maximize the goals of the 2019 EMP and Integrated Energy Plan, the collection of the EE/PDR charges and the SBC should be based on the percentage of GHG emissions avoided or saved versus energy usage throughput. In essence, as the electric system emissions get cleaner, the natural gas utilities would become more responsible for the overall statewide GHG emissions budget and also for the overall cost to jointly run the EE/PDR programs. This methodology would fully decouple revenues from expansion of EE/PDR programs to achieve both energy and GHG emissions reductions. Mr. Winka advocated for addressing the Utilities' inherent conflict of interest in pursuing EE and decarbonization by shifting from an energy throughput lost revenue mechanism to one based on GHG emissions reductions. More specifically, Mr. Winka suggested revising the LRAM and CIP to use the cost of GHG emission reductions as the decoupling / benchmark indicator. Mr. Winka asserted that, if the decoupling mechanisms truly decouple revenues from EE/PDR results, including building electrification, all of the Utilities should be agnostic to the collection mechanism and decoupling true-up mechanism.

TSLE expressed support for more C&I programs and full decoupling so that all Utilities have similar goals and objectives. TSLE asserted that, currently, Utilities' goals and objectives vary, which creates challenges for participating in the programs.

Response: Staff understands the continued interest in and advocacy for full decoupling. At this time, Staff's recommendation is to make no changes to the LRAM or CIP mechanisms but to explore potential changes as part of the next triennial review process.

VI. ENERGY EFFICIENCY AS A RESOURCE

Comments: Rate Counsel acknowledged that participation in the PJM forward capacity market ("FCM") benefits New Jersey customers by obtaining revenues that offset EE/PDR program costs. Rate Counsel expressed support for Staff's recommendation that the Board require electric utilities to offer EE resources from Triennium 2 program years into the FCM base residual auctions. Rate Counsel agreed that electric utilities should provide conservative estimates based on projected demand savings from the Utilities' core programs in order to avoid over-commitments. However, Rate Counsel expressed concern that the proposed parameters around cost recovery of PJM penalties were too broad and could allow for Utility recovery of penalties even if Utilities are negligent. Rate Counsel proposed specific alternative language indicating that recovery of PJM penalties will be considered on a case-by-case basis and limited to when core program budgets have been eliminated or reduced by more than 15%.

RECO noted that its experience in the first triennium was that bidding into the FCM required significant expenditures from RECO's evaluation budget to develop and implement the FCM-required measurement and verification plan and provided a relatively small return. RECO requested that the Board provide Utilities with the ability to determine whether they should bid into the FCM based on their assessment of whether such bidding would be cost-effective.

Response: Staff appreciates Rate Counsel's comments and suggestions and has made some revisions to this section in response. In particular, Staff recommends that, if Utilities incur any PJM penalties or losses, they may petition to recover such losses or penalties incurred in a subsequent cost recovery filing, providing support that they exercised prudence in their FCM offers and acted reasonably with respect to their positions in the Incremental Auctions or in the secondary market.

Regarding the cost-effectiveness of bidding, Staff recommends that the Board allow a Utility to seek a waiver of the requirement if the Utility anticipates that it will not be cost-effective to fulfill the requirement.

VII. EM&V

Comments: Mr. Winka expressed appreciation for the work of the EM&V Working Group and the Statewide Evaluator. He agreed with the recommendations.

Response: Staff appreciates the comment.

A. EM&V Administrative Structure and Working Group

Comments: NJUA commented that the Utilities spent a significant amount of time during Triennium 1 coordinating EM&V efforts and collaboratively participating within the EM&V WG to implement robust EM&V processes while remaining conscious of impacts of those processes on customers, trade allies, and achievement of CEA goals. The Utilities agreed with continuing the EM&V WG and regularly reporting out to the monthly EE stakeholder meetings. The Utilities commended Staff for the effort undertaken during Triennium 1 to develop rigorous EM&V guidelines for Triennium 2 and agreed with the importance of documenting processes and having a clear understanding of EM&V expectations and savings calculations.

EEA-NJ requested improved involvement and transparency from the EM&V WG, including through more updates and opportunities to engage with BPU on EM&V studies and updates to the NJCT and Technical Reference Manual ("TRM"). As another example, EEA-NJ appreciated the SWE report-out to the monthly EE stakeholder group last year and requested expansion of this type of engagement in Triennium 2.

Uplight also requested more transparency from the EM&V WG.

Response: Staff acknowledges the interest in greater transparency and feedback. Staff recognizes and appreciates the positive comments about SWE report-outs to the monthly EE stakeholder group. Now that processes are becoming more settled, Staff and SWE plan more frequent report-outs, which will include process and study progress and results for the EM&V WG and its Committees.

B. Evaluation Studies

Comments: NJUA commented that the Utilities and other stakeholders should be able to work collaboratively through the EM&V WG to plan, develop, and review evaluation studies performed during Triennium 2. The Utilities also agreed that there should be a set budget for EM&V studies and work but urged caution regarding setting Triennium 2 budgets for impact and process evaluations based on Triennium 1 programs. Rather, the Utilities noted that their EM&V budgets for Utility process and impact evaluations will be developed with typical budgetary ranges that fall within industry standards for EM&V work and filed as part of Triennium 2 plan filings. The Utilities also noted that they will continue to coordinate Utility EM&V efforts where appropriate in Triennium 2.

EEA-NJ expressed interest in having more access to review EM&V and evaluation studies.

Honeywell suggested that implementers should have an opportunity to provide feedback on evaluation study guidelines covering State and Utility study standards and content before they are finalized to address potential conflicts or inconsistencies before executing an evaluation. Honeywell expressed concern about an inherent conflict in SWE developing the guidelines and also reviewing the Utility evaluations for conformance with the guidelines. Rather, Honeywell suggested that Utilities should have control over what the Utility evaluators conduct. Moreover, Honeywell noted that evaluation timelines need to give programs sufficient time after changes are enacted to evaluate programs.

Honeywell asserted that evaluators should identify data requirements at the design stage and review them with Utilities and implementers to ensure consistent, effective, and necessary data collection. Honeywell also called for a process to objectively compare SWE evaluations and Utility third-party evaluations to address inconsistencies and conflicts in results.

Regarding annual evaluation memos, Honeywell stated that implementers need direct access to these memos so that they can actively manage changes. Honeywell also argued that program administrators should be provided with more than two weeks to respond with comments on evaluation memos in order to adequately assess all results and recommendations.

Recurve suggested that greater transparency of evaluations would be achieved if software similar to their (open, accessible, and transparent) product was used for some evaluation applications.

Uplight advised that sharing the evaluation guidelines and soliciting comments from stakeholders will ensure transparency and that the guidelines are in line with industry across other states.

Response: Staff appreciates the interest in greater access to and ease in understanding and reviewing evaluation reports, whether by EM&V WG members or by non-members. Within the EM&V WG, Staff and the Statewide Evaluator will continue to confer with each other and EM&V WG members about how to appropriately balance transparency, collaboration, timeliness, and other factors as part of the effective management of a robust collection of evaluation studies. For non-EM&V WG members, as mentioned above, Staff and SWE plan to conduct more frequent report-outs to the monthly EE stakeholder group, including study progress and results from the EM&V WG and Committees.

Regarding guidelines, a stakeholder committee is involved in reviewing these documents, and they will be available for public review. Regarding review and SWE independence, Staff notes that SWE was hired as independent evaluation experts, and as such, were intended to provide independent oversight and assessment of the Utility and state evaluations. Having Utilities have total control over the evaluations with no oversight would not be third-party independent oversight. SWE is positioned for and was hired for this expertise for technical review, quality standards, and process development.

Regarding timelines, Staff notes that, in this first Triennium, many new activities and needed products were developed, and lessons were learned about timelines, which will help to improve timelines in Triennium 2.

Regarding the Recurve software, Staff will continue to learn more about best practices and options for quantifying program impacts. The current approach is to use traditional impact evaluation on both the residential and commercial sides, and the SWE team was hired to help New Jersey upgrade its evaluation standards.

C. Goal Setting Process

Comments: NJUA and the Utilities reserved their right to supplement their comments after the goal setting study and all supporting appendices have been released.

NJ 50x30 Building Electrification expressed interest in ensuring that there will be Triennium 2 goals for heat pumps.

Response: Staff thanks the commenters for their attention to this topic and looks forward to continuing engagement.

D. Evaluating Energy Savings

i. Technical Reference Manual

Note: *Attachment D includes summaries and responses to comments on specific TRM inputs.*

Comments: Rate Counsel supported the annual TRM update process, calling it a well-managed solution that provides an improvement over the past and that will balance ensuring current factors are always available and support stability and predictability in programs and planning.

NJUA noted significant joint Utility effort to create and maintain a coordinated measure list to ensure consistency in counting savings when guidance was not yet available in New Jersey. NJUA commended Staff for the development of a comprehensive TRM update for Triennium 2.

Regarding annual versus triennial TRM updates, NJUA argued that having savings values that do not change unexpectedly during a triennium for the purposes of evaluating compliance is beneficial for all parties, mitigates the potential for risk premiums being embedded in costs, and avoids downstream implications for vendor contracts, customer commitments, and budgets. More specifically, regarding Staff's proposal to calculate primary metrics based on annual TRM updates and secondary metrics based on the Triennium 2 TRM, NJUA advocated for not updating the TRM annually, arguing that having dual metrics unnecessarily complicates and has negative implications for program implementation, introduces additional administrative costs (based on ramifications for tracking and reporting systems and regulatory reporting), creates a moving target when plan budgets are fixed for the triennium, and may lead to additional risk hedging if Utilities embed risk premiums in program costs. NJUA argued that, at the most, annual TRM updates should be limited to codes and standards changes, correction of errors, and incorporation of new measures, with other parameters incorporated into the subsequent Triennial TRM.

NJUA and the Utilities also stated that TRM recommendations for Triennium 3 should not be introduced in Triennium 2.

EEA-NJ noted that, if annual TRM updates are adopted, there should also be an opportunity for stakeholders to be made aware of and provide input on the process to allow for transparency.

Uplight also suggested improving notice about TRM updates and increasing public stakeholder participation in the TRM update process.

Response: Staff considers annual TRM updates a foundation of a good, integrated program evaluation system. Evaluations assess program delivery and net and gross program impacts and provide direct feedback about the performance of the programs and the effectiveness of the investment, including progress of those programs beyond what would have happened without the interventions. Savings estimates that do not move over time to reflect real-world changes in markets (which are reflected in the updated TRM values) will provide unacceptably worse and worse approximations of the attributable savings for the programs. The State will not have adapted, updated information on its progress toward goals. The State will not know if its investment is well-spent. Utilities will not gain early feedback on needed programs adjustments if evaluations are not conducted regularly and incorporated into updated TRMs and used.

Because Staff recognizes that the Utilities are apprehensive about moving from Triennium 1 to Triennium 2 with the introduction of real financial implications (i.e., performance incentives and penalties), Staff already provided a significant compromise in Triennium 2 procedures. The most accurate savings tracking is provided using annually-updated TRMs. Locked-down TRMs reduce financial risk to the Utilities and QPIs. Staff proposed and continues to recommend requiring reporting on two (2) metrics: net savings estimates using a mostly-locked down TRM for Utility incentives (with the exceptions specified) and net savings calculated using the annually-updated TRM to provide stakeholders and the State with a better estimate of attributable savings. Two (2) sets of books are more complicated, but it is a process that was carried out in Triennium 1 to accommodate the Utilities' preference to keep the TRM locked down for QPI / incentive purposes.

Staff understands why Utilities would include risk premiums and risk hedging in reaction to uncertainty but also believes that the Utilities should run programs based on reasonable market expectations and should avoid budgeting undue costs.

Staff notes that the recommended EM&V processes provide for annual TRM updates that include a public stakeholder review process prior to Staff developing recommendations for consideration by the Board.

Comments: Regarding application of realization rates ("RRs") (included as Appendix I to the Triennium 2 TRM) separate from in-service rates ("ISRs"), NJUA argued that the applying RRs from the first program transition year to Triennium 2 would result in less accurate estimates of savings achieved in Triennium 2. NJUA also stated that RRs are not commonly captured in the TRMs of other nearby states such as New York, Pennsylvania, and Maryland where the Utilities have extensive program experience and that, in most jurisdictions that include them, RRs are applied to ex-ante results from the period in which they are measured rather than prospectively based on prior year or years' performance. NJUA argued that it is appropriate to continue to collect New Jersey-specific data and for the EM&V Working Group to consider the appropriate way to incorporate robust data from a more stable program portfolio into planning and evaluation results.

JCP&L commented that the proposed application of RRs and NTG components will have a significant negative impact on calculated program savings and a corresponding increase in program costs to customers.

PSE&G expressed support for the detailed comments and feedback filed by NJUA on the EM&V straw proposal and associated attachments. PSE&G offered comments on specific TRM inputs (detailed in Attachment D).

SJIU noted that one (1) out of two (2) of its Utilities was assigned a RR and expressed concern that RRs may lead to inconsistent treatment of programs and measures across Utility service areas.

Response: Staff notes that, as more robust data on the results of Utility and State programs become available, the need to apply a RR may decrease. However, application of RRs is important in the early years of program implementation, when there are some uncertainties in initial savings values, a priori calculations, and other elements of accurate savings accounting.

Staff believes that RRs should be applied in all cases where a new impact study has not generated a new, updated, enhanced-level saving estimate for the program or measure. If that is not the case, the savings estimate should be calculated using the TRM a priori computation times the latest verified ISR times the RR.

RRs stand in for parameter updates when specific parameters were not studied or when the effects of impact evaluation results for multiple parameters cannot be isolated from each other.

RRs are an essential tool in an effective evaluation framework because they greatly increase flexibility in planning and interpreting impact evaluation results. They are widely used to help support publicly-funded EE programs in other states, particularly in leading states.

RRs have been adjusted to account for verified changes to tracking systems and calculations and can be applied prospectively.

Comment: EEA-NJ and Uplight suggested increasing public stakeholder participation in the TRM update process.

Response: As included in the EM&V straw proposal, Staff recommends soliciting input from public stakeholders on proposed triennial TRM revisions prior to developing recommendations for the Board's consideration. Otherwise, regarding more informal public input on triennial TRM revisions or annual TRM updates, Staff believes that it is not practical to expand the technical TRM Committee beyond the Utilities, their evaluators, and Rate Counsel. Staff recommends continuing the current design and membership of the technical TRM Committee. Toward the end of expanding public stakeholder participation in the TRM update process, however, Staff and SWE appreciate stakeholder interest in engaging more deeply and frequently on future revisions to the TRM and will add more frequent EM&V Working Group updates and discussions, including regarding the TRM, to the EE stakeholder meetings (which may take place on a different schedule starting in Fiscal Year 2024). Further, Staff and SWE will endeavor to provide longer review times for comment on future triennial TRM revisions. Staff also notes that evaluation studies, including those that inform annual and triennial TRM changes, are posted on the NJCEP website as they become available.

ii. Net-to-Gross ("NTG") Factors

Note: *Attachment E includes summaries and responses to comments on specific NTG inputs.*

Comments: Rate Counsel supported the introduction of more valid NTG numbers and appreciated the expertise and experience brought to the evaluation work that supported the significant step of moving New Jersey from its previous practice of allowing for 1.0 NTG values for all measures. Rate Counsel noted that the application of NTG values should ensure that savings claimed by Utilities and the State more closely reflect the true savings associated with their ratepayer-funded programs. Rate Counsel noted the importance to ratepayers of applying NTG values based on the best available data, noting that the proposed values were literature-based and could be reviewed toward the end of developing a simplified, more certain, and more conservative representation of NTG values. Rate Counsel identified an approach of using the high end of each range of NTG values identified by the consultant NMR instead of using the 50^{th} percentile value.

Using an illustrative example of savings counted for an efficient refrigerator, NJUA argued that NTG ratios – based on the hypothetical actions that customers may have undertaken if incentive programs did not exist – will have a major impact on the savings achieved from the programs, overall State progress toward meeting CEA objectives, and additional program costs borne by customers compared to Triennium 1 when the Board allowed for a NTG ratio of 1:1. NJUA agreed that NTG is an appropriate screening tool in evaluating the cost-effectiveness of programs. However, NJUA disagreed that net savings should be used to evaluate Utilities' compliance with the CEA and argued that gross savings should count toward the Utilities' goals, referencing that this is the practice in nearby states such as New York, Pennsylvania, and Maryland.

JCP&L, NJNG, NJBIA, and NJLEUC submitted comments in support of NJUA's arguments. NJNG emphasized that it is critical to consider NJUA's recommendations to improve the accuracy of savings claimed and that all energy savings are counted. NJBIA argued that all savings achieved by EE measures should count toward CEA goals. NJLEUC argued that all efficiencies achieved through utility programs should count toward CEA efficiency goals. JCP&L provided additional analysis using the same efficient refrigerator example discussed in NJUA's comments to illustrate the reduction in counted energy savings that would result from application of a NTG factor. JCP&L echoed NJUA's comments that there would be negative implications of those reductions on the Utilities' ability to achieve program goals and on program costs due to the need for more expenditures to achieve energy savings compared to Triennium 1, NTG did not apply.

JCP&L further argued that gross savings reflect the actual energy and demand savings occurring in the state and that the CEA's allowance for counting energy savings from codes and standards supports JCP&L's position that it does not make sense to utilize net savings when determining compliance with the CEA's savings requirements. In short, JCP&L expressed its belief that the intent of the CEA was to count gross savings. In conclusion, JCP&L stated its belief that gross savings are the appropriate measurement for determining Utility compliance with targets, QPIs, and lost revenues.

Response: Staff appreciates the support for the NTG study and believes that the recommendations from the study represent a significant and defensible basis for the State as it adopts a NTG approach in New Jersey that more closely estimates the savings attributable to programs.

Staff understands the impetus behind Rate Counsel's interest in using more conservative NTG values but agrees with the recommendations in the NTG report that using the 50th percentile value is appropriate because it guards against selecting the best-case scenario value that may overstate program-induced savings, which would then lead to large downward adjustments on savings when primary NTG values from New Jersey become available.

Staff believes that net values should be used to assess the compliance of Utility- and State-led EE programs with the CEA. The CEA calls for QPI methodology that ensures that a public utility's incentives or penalties are based upon performance, and it states that a "public utility may apply all energy savings attributable to programs available to its customers" (emphasis added). Staff believes that a reasonable interpretation of the CEA is to have public utilities apply toward their energy savings targets the savings that are reasonably determined to be generated or caused by the public utility's programs. In addition, Staff believes that net values should be used to reflect best estimates of progress caused by the programs (especially relative to the efforts and investment expended) and to avoid inflating progress numbers by incorporating achievements that the programs did not create. Using net savings also has the advantage of providing an incentive to the Utilities to maximize the pursuit of savings that would not otherwise occur, which is one of the fundamental objectives of the programs. However, Staff also notes that this topic will be more fully addressed in the subsequent straw proposal pertaining to Triennium 2 goals, targets, and performance incentive mechanism.

E. Benefit-Cost Analyses ("BCAs") / Cost-Effectiveness Testing

i. New Jersey Cost Test

Note: *Attachment G includes summaries and responses to comments on specific NJCT inputs.*

Comments: Rate Counsel expressed strong concern that the proposed NJCT comprised sweeping and unreasonable changes to the NJCT (citing six new variables and changes to eight of the original 16 benefit variables in the NJCT) without adequate reasoning and without adequate evidence about the impacts of those changes or the benefits of the changes to ratepayers; represented an over-emphasis on the benefits of EE programs; would cease to be a useful cost-effectiveness tool; and would enable inefficiencies in EE investment, inflated EE program spending, unnecessary rate increases, higher utility costs, and negative impacts on the state economy.

Rate Counsel also recommended that, should the Board wish to explore some of the cost test methods proposed in the straw, the Board should order the Utilities to provide some comparison cost test analyses to the current NJCT in their Triennium 2 filings so that the Board can better evaluate the implications of changes to the NJCT as part of evidentiary proceedings, including cross-examination of witnesses. More generally, Rate Counsel also characterized the development of the proposed NJCT through the NJCT Committee as utility-dominated and invitation only and called for more of a public process (i.e., evidentiary proceeding including evidence and cross-examination) to develop changes to the NJCT.

Rate Counsel used the NJCT results from JCP&L's Triennium 1 filing to prepare a preliminary or limited analysis that concluded that applying the proposed NJCT to JCP&L's Triennium 1 filing would more than double the company's overall cost-benefit ratio from the as-filed ratio of 3.5 to 8.2 using many of the proposed NJCT inputs. Of the four categories of variables – (1) energy-related proposals (escalation, natural gas DRIPE); (2) emissions-related proposals (CO2 and other criteria pollutant benefits); (3) other proposed benefits (avoided RPS, economic development, and volatility); and (4) non-energy benefits ("NEBs") – economic development (59%) and other criteria pollutant benefits (20%) were the two benefits that resulted in the largest increased share of incremental benefits.

Rate Counsel also provided analysis of individual proposed NJCT variables. Notably, in its analysis of NEBs adders, Rate Counsel stated that it did not support the recommendations provided by the Statewide Evaluator due to the wide range of data and information in the meta-study (vs. peer-reviewed studies, for example) that SWE offered to support its recommendations. Rate Counsel stated that 31 states do not use NEBs and states that use NEBs have values comparable to New Jersey's current levels. Rate Counsel encouraged the Board to maintain its already appropriate NEB values for overall programs (5% adder) and low-income programs (10% adder) rather than increasing to 23% and 36%, respectively, as proposed or alternatively to only increase NEBs by 5% if the Board finds it reasonable to increase NEBs at all.

NJUA expressed support for the majority of NJCT recommendations, citing the many hours of working group time spent in the NJCT Committee among the Utilities, Staff, Rate Counsel, and their respective consultants on the NJCT. NJUA stated its belief that the proposed benefits accurately reflect both the policy goals of the State and the financial impacts of those benefits, including more accurate representation of the social benefits of EE through the NEBs adders than the prior values. NJUA also expressed support for the proposal to update the structure and values of the NJCT prior to each triennium for application in that triennium. NJUA also requested the addition of avoided water use in the NJCT. Finally, NJUA did not endorse the use of an adder to represent avoided costs, asserting that avoided costs components and methodologies have already been developed.

NEEP noted the importance of taking a complete and balanced analysis of EE program impacts by accounting for the environmental and societal impacts of our energy system when assessing the cost-effectiveness of the programs. In particular, accounting for non-energy impacts or NEBs in benefit-cost analyses can help regulators to begin to identify the environmental and societal costs and benefits that are unaccounted for in energy policy and thereby deter investment in programs that do not align with state policy, such as delivered fuels or natural gas. NEEP agreed with the SWE's recommendation that BPU update the NJCT prior to each triennium with stakeholder input and Board approval. NEEP also encouraged the Board to consider a more substantial stakeholder process to outline the policies, metrics, and amounts assigned to each input in the NJCT.

Based on adders recommended by literature and average adders used by states and as outlined in NEEP's NEBs Memo, NEEP recommended the following for Triennium 2:

- A low-income NEBs adder of at least 20% to drive equitable program design with the potential for programs to include benefits for reducing hardship;
- A health adder of 10% for residential HVAC electrification programs;
- A base participant NEBs adder of 10% for all residential programs and 15% for all commercial programs; and
- Increasing the metric for the social cost of carbon to $128 per short ton to align with New York and Massachusetts methodology and price and Connecticut's price, as states with similar climate goals and priorities to New Jersey.

NEEP also recommended consideration of a metric to account for the real time cost of energy generation, such as a Total Systems Benefit, in Triennium 3.

Mr. Winka expressed support for including avoided SO2, NOx, and PM2.5 emission impacts and net economic development benefits in the NJCT. Mr. Winak also expressed appreciation for the discount rate of 3% compared to the typical textbook rate of 7 or 8%, but he recommended a rate lower than 3% because of the small potential but extremely large impact of damages from global climate change. Mr. Winka cited two (2) research / policy papers in particular to support his recommendation of a discount rate of 1.4% based on the need for a large investment to present future climate damage.

BPA commended the NJCT Committee, SWE, and Staff for the focus in the straw proposal and memo on aligning the NJCT with state policies, ensuring transparency and opportunity for stakeholder input in the process, and incorporating other key elements of the National Standard Practice Manual principles, as detailed in BPA's comments. Overall, BPA recommended that New Jersey formally cite and utilize the National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources ("NSPM") as a framework for considering updates to the NJCT. BPA recommended the NSPM as a tool that can help New Jersey meet its energy policy goals since the NSPM provides guidance for developing a primary jurisdiction-specific BCA test through a set of eight core principles designed to represent sound economic and regulatory practices.[1] In particular, BPA applauded the increases of NEBs adders based on the literature review indicating that EE program activity generates higher non-energy impacts, noting the NSPM's symmetry principle and citing NSPM's explanation that "approximating hard-to-quantify impacts is preferable to assuming that the relevant benefits and costs do not exist or have no value." BPA also expressed support for proposed changes and updates to avoided electric energy costs, avoided electric transmission and distribution costs, and avoided natural gas costs that would use forward-looking analyses to calculate costs in alignment with the NSPM's principle that cost-effectiveness analyses should be forward-looking, long-term, and incremental to what would have occurred without the distributed energy resources.

As a complement to the NJCT and to ensure a broader decision framework for EE investments, BPA also encouraged Staff, the NJCT Committee, and the SWE to consider forthcoming guidance scheduled for publication in the fall of 2023 by the Lawrence Berkeley National Laboratory and E4TheFuture regarding Distributional Equity Analysis. This project will address limitations of BCA and how DEA can be used with BCA to inform distributed energy resource ("DER") investment decisions. BPA recommended that New Jersey establish a unified BCA framework (i.e., conducting a DEA alongside BCAs) for EE and all other DERs to ensure that New Jersey meets its equity goals.

EEA-NJ similarly offered commendations for the focus in the straw proposal and memo on aligning the NJCT with State policies, ensuring transparency and opportunity for stakeholder input in the process, and incorporating other key elements of NSPM principles. EEA-NJ endorsed the increases of NEBs in the NJCT, stating that these adders allow for a more accurate balance on the scales when assessing the true costs of EE measures, provide a more holistic approach when addressing the full impacts of energy burdens on consumers, and will help expand the adoption of measures where the need is highest in low-income residences, which are typically the worst performing.

MaGrann expressed strong support for the increased NEBs adders, characterizing these incremental values as consistent with the NSPM recommendations and other initiatives aimed at better aligning cost-effectiveness testing with the intent of capturing all benefits. MaGrann argued that it is critical to not overly constrain the value assigned to these benefits such so as to be able to approve more costly

[1] https://www.nationalenergyscreeningproject.org/national-standard-practice-manual

projects with longer-term paybacks and deeper energy savings instead of lower efficiency, higher carbon generating projects that last 20 to 30 years or more. MaGrann also expressed strong support for the proposal to base applicable cost-effectiveness calculations on incremental costs. In addition, MaGrann expressed support for the proposal to remove non-energy policy items from the cost-effectiveness calculation (e.g., workforce development initiatives).

TSLE noted that the NJCT should represent the benefits of programs serving underserved markets and diverse communities and firms.

Response: Staff understands and appreciates Rate Counsel's concerns about the costs of EE programs and the potential for the addition of more benefits in the NJCT to lead to the inclusion of less cost-effective measures in EE incentive programs relative to a cost test that accounts for fewer benefits. Staff notes that, regardless of the effect on BCR, the inclusion of updated values for NEIs does not in itself increase or affect program budgets in New Jersey's framework. The significant progress still needed to achieve goals is or will be the driver for program budget increases. The Utilities are required to have portfolios with BCRs of at least 1.0 but are not required to implement every program with a BCR of 1.0 or better.

Staff also appreciates stakeholder comments emphasizing the importance of including energy and non-energy benefits in the NJCT.

Staff believes in the importance of having a primary cost test for New Jersey EE programs that strikes a balanced and reasonable approach to accounting for the costs and benefits of EE programs.

During Triennium 1, Staff, SWE, and others recognized the need for a dedicated work group focused on potential revisions to the NJCT. The NJCT Committee included Staff, SWE, the Utilities, Rate Counsel, and their respective consultants. The work of this NJCT Committee resulted in the straw proposal for the Triennium 2 NJCT.

Staff thanks NEEP for its recommendation to consider a metric to account for the real time cost of energy generation, such as a Total Systems Benefit, in Triennium 3.

Regarding BPA's suggestion that New Jersey formally cite and utilize the NSPM as a framework for considering updates to the NJCT, including through the NSPM's set of eight core principles, while the NJCT Committee did not formally use this document, its deliberations explicitly incorporated the key long-standing evaluation principles that are aggregated into that document. This includes: including assuring cost test entries are consistent with State goals, matching costs and benefits and positive and negative effects, and including only those impacts (non-energy and otherwise) associated with the perspective(s) appropriate to the to benefit-cost ratio being used.

Staff thanks BPA for the suggestion about establishing a unified BCA framework and will plan to address this in discussions about the next NJCT.

Staff believes that it is not practical to expand the technical NJCT Committee beyond the Utilities, their evaluators, and Rate Counsel. Staff recommends continuing the current design and membership of the technical NJCT Committee. Toward the end of expanding public stakeholder participation in the NJCT update process, however, Staff and SWE appreciate stakeholder interest in engaging more deeply and frequently on future revisions to the NJCT and will add more frequent EM&V Working Group updates and discussions, including regarding the NJCT, to the EE stakeholder meetings (which may take place on a different schedule starting in Fiscal Year 2024). Further, Staff and SWE will endeavor to provide longer review times for comment on future triennial NJCT revisions. Staff also notes that evaluation studies and research, including those that inform NJCT updates, are posted on the NJCEP "Program Evaluations, Market Analysis and TRMs" webpage at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an as they become available.

VIII. REPORTING REQUIREMENTS

Comments: Stakeholders provided considerable input and comments regarding tracking, reporting, and metrics. Mr. Winka recommended that the quarterly reports provide the consolidated, statewide information, including numbers of participants in each program by municipality or zip code, as well as cumulative energy saved in MMBtus and MWh.

NJ 50x30 suggested that the Utilities should submit both individual Utility and consolidated Utility reports on savings, costs, and benefits to determine if the consolidated programs are cost-effective, including number of participants by municipality or zip code for each Utility program.

Rate Counsel suggested that GHG tracking not be included in the Utilities' quarterly reports. Rate Counsel further recommended that the State program administrator continue to monitor and report GHG emission reduction as Rate Counsel believes the State is in the best position to capture this information and make the necessary recommendations or changes to programs, as needed, to meet the State's emission reductions goals.

EEA-NJ stated that the tracking system should include reporting to track QPIs.

TSLE noted that transparent tracking against goals is needed.

Uplight recommended that quarterly and annual reports include metrics on LMI and multifamily program segments.

Response: Staff recognizes the interest of stakeholders in being able to review progress of the Utility and State programs on at least an interim basis in the triennium. Staff notes that the addition of a quarterly roll-up might be possible, but greater effort and attention will be placed on the annual Utility and State roll-up numbers. The planned annual or interim reporting includes enhanced lists of metrics with more information at the program level and already includes some information for LMI outcomes, but not at the zip code or city level. Staff notes, however, that Sustainable Jersey offers a Data Center at https://www.sustainablejersey.com/resources/data-center/sustainable-jersey-data-resources/ that includes multiple municipal-level data files and interactive maps, including on EE program participation, with support from Staff and the Utilities to provide applicable data needed as requested by Sustainable Jersey. For example, this information can be used by municipalities in developing their community energy plans through the BPU's Community Energy Plan Grant program, for which Sustainable Jersey provides guidance and technical assistance.

Staff supports addition of the GHG metric at least in the statewide compilation reports and will include a metric on this as soon as the conversion factor sources are vetted and agreed upon. Further, Staff is working on this and other improvements to the metrics and tracking efforts. The tracking reports and annual roll-ups will be posted on the NJCEP "Financial & Energy Savings Reports" webpage at https://www.njcleanenergy.com/main/public-reports-and-library/financial-reports/clean-energy-program-financial-reports. In addition, all Utility and State evaluation documents and a PDF of the TRM are posted on the NJCEP "Program Evaluations, Market Analysis and TRMs" webpage at https://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an

IX. TRIENNIAL REVIEW

Comments: NRDC recommended that the Board adopt an interim review process for evaluation and modification of program design to course correct as lessons are learned from implementation.

Response: Staff notes that, while the triennial review process occurs throughout the three years of each program cycle, in addition, there are certain opportunities to course correct within the overall Triennium 2 framework established by the Board. These include annual TRM updates as well as adjustments in the following areas: marketing and outreach, budgets and incentives, program rules to accommodate overlaps between Utility-led and State-led programs, and Utility-led and State-led program design and delivery to accommodate integration of IRA rebates. In addition, the Board always maintains the ability to modify or clarify aspects of the Triennium 2 framework as needed during the triennium.

X. STAKEHOLDER GROUPS

Comments: Rate Counsel expressed that it looks forward to continuing participation in the full range of working groups and to the continued sharing of best practices and improvements to program delivery and cost-effectiveness in New Jersey.

NEEP suggested that BPU can build on past achievements by providing additional opportunities for stakeholder engagement and involvement in the working groups. In particular, NEEP suggested providing more targeted meetings and opportunities for engagement, changing the format and content of meetings, and providing educational materials or a presentation. As an example, NEEP suggested that, when Utilities and the BPU file their program plans, each entity can hold public meetings with information presentations on their portfolio – including about the goals of the programs and metrics of success – and opportunities for verbal and written feedback. NEEP also suggested that BPU could plan additional stakeholder meetings on the building decarbonization start-up program, demand response programs, Comfort Partners, braiding low-income programs, establishing the New Jersey cost-benefit test, and federal funding opportunities. NEEP suggested its work on creating equity-focused advisory groups and the Community Engagement to Ownership spectrum, as well as other high-impact stakeholder processes in other states, including Connecticut and Massachusetts.

Honeywell asserted that it is critical that the Utility Working Group be open to implementers so that they can provide input and context on the issues addressed.

MaGrann strongly suggested a more robust marketing and outreach strategy for comprehensive Utility-led programs (e.g., Engineered Solutions, whole building electrification programs). MaGrann recommended that the Utilities integrate a marketing strategy across all programs so that customer contacts from projects that may have gone through one program may be leveraged when targeting outreach for another program.

NRDC recommended that the Board revise the EE stakeholder and working group process to provide interested parties with more opportunities to comment, whether through allowing interested stakeholders to participate in the Utility Working Group, reviving the Energy Efficiency Advisory Group, or making permanent the Clean Buildings Working Group.

Response: Staff appreciates the interest in, and agrees with, the importance of increasing effective stakeholder engagement. Staff welcomes continued dialogue with interested stakeholders about how to continue to improve stakeholder engagement processes, which could include redesigning the monthly EE stakeholder meetings to enable more in-depth discussions about topics of interest. Staff always appreciates the opportunity to benefit from stakeholders' insights, experiences, and recommendations and to engage collaboratively to develop the best possible clean energy policies. In general, Staff appreciates the suggestions and will explore possible changes to expand opportunities for stakeholder engagement starting in Triennium 1.

In addition to forthcoming meetings regarding the remaining aspects of the Triennium 2 framework – including building decarbonization start-up and demand response programs – Staff anticipates that there will be further opportunities for stakeholder input after the Board establishes the overall Triennium 2 framework – notably, because of the continued work that will be required to determine how to most efficiently and effectively leverage additional funding from the IRA efficiency and electrification rebates to maximize the benefits of existing programs. Staff will propose plans for how to leverage any additional funding, which may include adjustments to Utility and State program design and delivery as needed, for feedback from public stakeholders.

Staff also agrees that offering additional stakeholder meetings on proposed Utility and State EE programs would provide expanded opportunities for stakeholders to learn about and provide feedback on the proposals. As noted above in the section regarding Utility core programs, Staff plans to foster more dialogue with stakeholders about the Utilities' proposals to inform the Board's filing review process that will occur between October 2023 and May 2024. All of the Utilities will have public hearings regarding their Triennium 2 proposed programs, which are open to all stakeholders, and suggests that these are important fora through which stakeholders can provide feedback to the Utilities and Staff about program details. In particular, Staff will work with the Utilities to plan how best to use these public hearings, which may include presentations designed to benefit stakeholders and more actively invite feedback.

Attachment C

New Jersey 2023 Triennial Technical Reference Manual

For 2024 Filings

New Jersey Board of Utilities

New Jersey's Clean Energy Program™

5/22/2023

1 TABLE OF CONTENTS

1 INTRODUCTION

This technical reference manual (TRM) has been developed to calculate resource savings, including electricity, natural gas, and other resource savings from technologies and measures, and to calculate electric energy and capacity savings from renewable energy and distributed generation systems. Specific calculation methods for determination of the resource savings or generation are presented.

These calculations use deemed and customer-specific data as input values to industry-accepted energy and peak demand savings algorithms. The data and input values for the algorithms come from the program application forms or from deemed values. The deemed values are based on the recent impact evaluations or best available secondary research applicable to the New Jersey programs when impact evaluations are not available.

1.1 PURPOSE

The TRM was developed for the purpose of calculating energy and peak demand savings for technologies and measures supported by New Jersey's Clean Energy Program (NJCEP). This includes programs administered by the State of New Jersey through the Board of Public Utilities (BPU), the State's electric and natural gas utilities, or other parties who administer clean energy programs under the guidance of the BPU. The TRM will be updated to reflect the addition of new measures, modifications to existing measures, changes to codes and standards, and the results of evaluation studies. The TRM will be used consistently statewide to assess program impacts and calculate energy and peak demand savings consistent with BPU guidance. The TRM may be used to accomplish the following:

- Report to the BPU on program performance;
- Provide inputs for program planning and cost-effectiveness calculations;
- Provide information to the BPU for calculating Quantitative Performance Indicators (QPI) and applying the Performance Incentive Mechanism (PIM);

Resource savings to be measured include electric energy (kWh) and demand (kW) savings, natural gas savings (therms), peak gas savings (therms/day), and savings of other resources (oil, propane, gasoline, and water) where applicable. In turn, these resource savings will be used to determine avoided environmental emissions and other benefits as described in the New Jersey Cost Test. The TRM is also utilized to support preliminary estimates of the electric energy and capacity from renewable energy and distributed generation systems and the associated environmental benefits.

The calculations in this document focus on the determination of the per unit savings for the energy efficiency measures, and the per unit generation for the renewable energy or distributed generation measures. The BPU has adopted net savings for the purposes of evaluating energy efficiency and peak demand reduction program performance, and performing cost-effectiveness testing. For Triennium 1, the BPU adopted a net-to-gross ratio of 1.0, which should be applied to all programs, including low- income programs. For Triennium 2, net to gross ratios used to calculate net savings are shown in Appendix H: Net-to-Gross Factors and should be applied to the gross savings calculated from this TRM.

1.2 TRM ORGANIZATION

The TRM is organized by customer sector (Residential and Commercial) and by end-use. Within each end-use section, measures are grouped together by end-use subcategory. Note, sector applicability to measures installed multifamily (MF) buildings depends on whether the building is a low rise (3 stories or less) and whether the measure is located in the individual unit or common area. In-unit measures and all measures in MF low-rise buildings are covered in the Residential section. Measures in common areas of MF high-rise (more than 3 stories) buildings are covered in the Commercial section. Measures used in low-income (LI) or moderate income (MI) programs use the same TRM sections as measures applied to the general population. Any calculations unique to LI or MI programs are identified within each measure section. Measure applied to Agricultural facilities are covered within the Commercial section under the Agricultural end-use.

1.3 TYPES OF CALCULATIONS

The following table summarizes the spectrum of approaches to be used for calculating energy, demand, and resource savings. No one approach will serve all programs and measures. The TRM provides algorithms addressing measure types 1 and 2, and general guidelines for measure type 3.

Table 1-1 Summary of Calculations and Approaches

Type of Measure	Type of Calculation	General Approach	Examples
1. Deemed prescriptive measures	Standard formula and deemed input values	Number of installed units times deemed savings/unit	Residential appliances
2. Measures with important variations in one or more input values (e.g., , efficiency level, capacity, load, etc.)	Standard formula with one or more site-specific input values	Standard formula in the TRM with one or more input values coming from the application form, worksheet, or field tool (e.g., , efficiency levels, unit capacity, site-specific load)	Residential Electric HVAC (change in efficiency level times site-specific capacity times standard operating hours); Field screening tools that use site-specific input values
3. Custom or site-specific measures, or measures in complex comprehensive jobs	Site-specific analysis	Greater degree of site- specific analysis, either in the number of site-specific input values, or in the use of special engineering algorithms, including building simulation programs	Custom Industrial process Complex comprehensive jobs

Several systems work together to ensure accurate data on a given measure:

1. The application form that the customer or customer's agent submits with basic information.
2. Application worksheets and field tools with more detailed site-specific data, input values, and calculations (for some programs).
3. Program tracking systems that compile data and may do some calculations
4. The TRM that contains algorithms and relies on deemed or site-specific input values. Parts or all of the TRM may ultimately be implemented within the tracking system, the application forms and worksheets, and the field tools.

1.4 ALGORITHMS

The TRM presents a set of engineering algorithms to calculate energy and demand savings. Savings are generally driven by a change in efficiency level for the installed measure compared to a baseline level of efficiency. Energy savings are calculated from the change in efficiency and/or the change the annual operating hours of equipment. Operating hours may be expressed as run hours for constant output devices or equivalent full load hours (EFLH) for equipment that operates at varying levels of output throughout the year. Energy and demand savings may be calculated for both electricity and natural gas regardless of the targeted fuel.

1.5 BUILDING ENERGY SIMULATIONS

When building energy simulation software is used to develop savings estimates for several measures in a comprehensive project, the specific algorithms used are inherent in the software and account for interaction among measures by design. Building simulation software used for any program must be compliant with one of the following:

- A software tool addressing residential and/or commercial buildings whose performance has passed testing according to the National Renewable Energy Laboratory’s BESTEST software or ASHRAE Standard 140 energy simulation testing protocol,
- Software approved the US Department of Energy's Weatherization Assistance program, or
- RESNET approved home energy rating software (HERS).

1.6 MEASURE INTERACTIVE SAVINGS

Throughout the TRM, the interactive effect of thermostatically-sensitive building components is accounted for in specific measure sections, as appropriate. In instances where there is a measurable amount of interaction between two energy consuming sources, the energy or peak demand savings are accounted for in either the algorithms or in the modeling software used to determine energy savings.

For example, in a measure section where the lighting load has a direct effect on the energy used to condition the space, the TRM provides an interactive effect value to be used in the savings algorithm for certain measures. Other measures rely on the characteristics of the modeling software that account for the effect within a building, such as a new construction protocol software that will apply the effects for a measurable difference in the baseline and efficient buildings.

Measure savings calculation based on simple engineering algorithms are not designed to account for the interactive effects of multiple measures installed in a building. When multiple measures are installed, it is acceptable to sum the individual measure savings. Energy savings calculations based on building energy simulations account for multiple measure interactions by design.

1.7 DATA AND INPUT VALUES

Some input values, including site-specific data, will come directly from the program application forms, worksheets, and field tools. Site-specific data on the application forms are used for measures with important variations in one or more input values (efficiency level, capacity, etc.).

Standard input values are based on the best available measured or industry data, including metered data, measured data from prior evaluations (applied prospectively), field data and program results, nameplate data, in situ values, and/or standards from industry associations.

For the deemed input assumptions where metered or measured data were not available, the input values (e.g., watts, efficiency, equipment capacity, operating hours, coincidence factors) are based on the best available industry data or standards. These input values were based on a review of literature from related evaluation studies and information from various industry organizations, equipment manufacturers, and suppliers. For custom projects, measurement and verification (M&V) options are presented that use pre- and/or post-retrofit measurements of energy consumption or equipment performance to estimate energy savings.

1.8 BASELINE ESTIMATES

For measures in which the existing equipment has failed, is at the end of its useful life, or the program administrator does not have knowledge of the state of the existing equipment, the resource savings values are based difference between the energy use of new products that meet code or represent industry standard practice vs. the high efficiency products promoted through the programs. For early replacement of functioning equipment, energy and demand savings values are based on the difference between high efficiency equipment versus existing equipment. A dual baseline approach must be followed, where the savings relative to the existing equipment baseline are used for the remaining useful life of the existing equipment and a code or standard practice baseline is used for the remaining life of the measure. In lieu of the dual baseline approach, lighting measures may use an adjusted measure life (AML) to account for early replacement of functioning systems and differences in the lifetimes of efficient vs. standard practice equipment. The AML is defined as the lifetime energy savings considering a dual baseline divided by first year savings.

Measures in the TRM are categorized according to the following baseline condition definitions:

Baseline Condition	Attributes
Time of Sale (TOS)	**Definition:** A program in which the customer is incented to purchase or install higher efficiency equipment than if the program had not existed. This may include retail rebate (coupon) programs, upstream buydown programs, online store programs, contractor based programs, or giveaways as examples. May include replacement of existing equipment at the end of its life (i.e., replace on burnout) or purchase of new equipment. In cases where a new construction characterization isn't explicitly provided, the TOS characterization is typically appropriate. TOS is sometimes referred to as normal replacement (NR). **Baseline:** New standard efficiency, code compliant, or industry standard practice equipment. **Efficient Case:** New, premium efficiency equipment above federal and state codes and standards and industry standard practice. **Example:** Appliance rebate
New Construction (NC)	**Definition:** A program that intervenes during building design, expansion, or gut rehabilitation to support the use of more-efficient equipment and construction practices. **Baseline:** Building code, federal standards, or industry standard practice. **Efficient Case:** The program's level of building specification **Example:** Building shell and mechanical measures

Baseline Condition	Attributes
Retrofit (RF)	**Definition:** A program that upgrades or enhances existing equipment. **Baseline:** Existing equipment or the existing condition of the building or equipment. A single baseline applies over the measure's life. When a measure is applied to existing operational equipment and the measure benefit will cease upon the end of the underlying equipment's life, the measure life is the smaller of the host equipment remaining life or the full measure life. **Efficient Case:** Post-retrofit efficiency of equipment. **Example:** Air sealing, insulation, controls
Early Replacement (EREP)	**Definition:** A program that replaces existing, operational equipment. **Baseline:** Dual. it begins as the existing equipment and shifts to projected TOS baseline equipment after the remaining life of the existing equipment is over. **Efficient Case:** New, premium efficiency equipment above federal and state codes and industry standard practice. **Example:** Refrigerators and freezers; early replacement of HVAC equipment. *Note: For lighting measures, the adjusted measure life (AML) may be used in lieu of a dual baseline approach.*
Early Retirement (ERET)	**Definition:** A program that retires inefficient, operational duplicative equipment or inefficient equipment that might otherwise be resold. No new equipment is installed in place of the old equipment, and no existing equipment use increases to compensate for the retirement. **Baseline:** The existing equipment, which is retired and not replaced. **Efficient Case:** Assumes zero consumption since the unit is retired. **Example:** Appliance recycling, delamping.
Direct Install (DI)	**Definition:** A program where measures are installed during a site visit and are assumed to replace existing, operational equipment. **Baseline:** Same as EREP. **Efficient Case:** Same as EREP. **Example:** Lighting and low-flow hot water measures *Note: For lighting measures, the adjusted measure life (AML) may be used in lieu of a dual baseline approach.*

1.9 PEAK SAVINGS

1.9.1 ELECTRIC COINCIDENT PEAK DEMAND

System peak demand refers to the highest amount of electricity consumed during a single hour across PJM. Peak coincident demand is the demand of a measure that occurs at the same time as the PJM system peak. PJM system peak is defined as follows in PJM Manual 18b:

"The EE Performance Hours are between the hour ending 15:00 Eastern Prevailing Time (EPT) and the hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, of such Delivery Year, that is not a weekend or federal holiday."

Therefore peak coincident demand savings should be calculated based on the average demand reduction during the hours in that time frame.[1]

Peak demand savings for non-weather sensitive custom measures should be calculated based on the average demand reduction during the hours in that period. For weather sensitive custom measures, peak demand savings should be calculated based on the PJM's Zonal Weighted Temperature Humidity Index ("WTHI") standards for the appropriate zone.[2]

1.9.2 PEAK DAY NATURAL GAS

Calculations have been developed to determine the natural gas energy savings on an annual and peak day basis. Additional calculations done as part of the cost effectiveness calculations allocate the annual savings on a seasonal basis. Peak gas savings are calculated on a therm/day basis, using peak day heating degree-days representing the weather conditions under which the natural gas distribution system reaches peak capacity. Design day conditions from the London Economics study are used to calculate peak gas savings:

Condition	Average Heating Degree days base 65 (°F – day)	Average Daily Temperature (°F)
Winter Design Day	66.4	-1.4

1.10 OTHER RESOURCES

Measures that save electricity or natural gas may also affect the use of other fuels, water or other costs, and will affect emissions. The New Jersey Cost Test accounts for emissions reductions associated with electricity and natural gas and the net direct and indirect economic benefit of these other factors. The NJCT-required outputs from TRM use are natural gas and electric energy and electric summer peak demand gross impact.

1.11 PROSPECTIVE APPLICATION OF THE TRM

The TRM will be updated annually based on evaluation results and available data, and then applied prospectively for future program years in accordance with applicable BPU direction. Prospective application of the TRM will include calculation of gross energy and demand savings from the applicable measure section modified by evaluation-derived in-service rates as presented in Appendix J: In-Service Rates, realization rates as presented in Appendix I: Realization Rates and net to gross ratios as presented in Appendix H: Net-to-Gross Factors.

1.12 MEASURE COSTS

Measure costs for use in cost-effectiveness calculations are presented in a separate document. Projects will use incremental costs and/or full measure costs depending on the baseline condition. Consult the measure cost document for information on how to calculate measure costs.

1.13 MEASURE LIVES

[1] Coincidence factors and peak demand savings provided in the TRM measure sections are based on best available information. These coincidence factors may not conform to PJM requirements for offers into the forward capacity market.
[2] See PJM Manual 18B, section 10.2.

Measure effective useful life (EUL) is provided in each TRM measure section for the purpose of calculating lifetime energy savings. Projects utilizing a dual baseline approach will rely on a combination of the existing equipment remaining useful life (RUL) and the new equipment EUL. Calculations of lifetime savings for retrofit projects involving add-on equipment such as controls will use the smaller of the measure EUL and the host equipment RUL. Measures where values for adjusted measure life (AML) are provided will use the AML in lieu of a dual baseline approach. Projects consisting of multiple measures that submit a single project wide savings claim should calculate a project level EUL based on the average of the EULs of the individual measures. For such projects where measure-level savings can be calculated, use the savings weighted average of the individual measure EULs. For projects where savings by end-use are available, assign an EUL to each end use based on the measures contributing to the end use savings and estimate the project level EUL as the end-use savings weighted average. For projects were savings by measure or savings by end use are not available, a project-level EUL based on the simple average of the measure EULs is acceptable.

2 RESIDENTIAL

2.1 APPLIANCES

2.1.1 CLOTHES WASHER

Market	Residential/Multifamily
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Clothes Washer
Measure Last Reviewed	January 2023

Description

This measure is for a new or replacement ENERGY STAR or ENERGY STAR Most Efficient residential clothes washer in single family or multifamily homes. Please note that common area laundry rooms in Multifamily buildings should follow the C&I methodology.

ENERGY STAR® clothes washers have a higher Integrated Modified Energy Factor (IMEF) and a lower Integrated Water Factor (IWF), saving energy and water with greater tub capacities and sophisticated wash and rinse systems. Rather than filling the tub with water, efficient wash cycles are achieved by spinning or flipping clothes through a stream of water. Efficient rinse cycles are achieved through high-pressure spraying instead of soaking clothes. Reduced dryer load represents additional energy savings associated with the thorough removal of water from the clothes in the washer.

Baseline Case

The baseline for energy savings calculations is a clothes washer meeting the federal minimum Integrated Modified Energy Factor (IMEF) and not exceeding the federal maximum Integrated Water Factor (IWF), as defined in 10 CFR 430.32(f)(2). The IMEF and IWF are determined by clothes washer configuration (top-load or front-load) and capacity. Energy usage includes the washer and dryer energy consumption and water heating energy usage.

Efficient Case

The energy consumption of the efficient equipment is calculated based on the IMEF and IWF of the ENERGY STAR version 8.1 specification or ENERGY STAR Most Efficient product and other variables as defined in the calculation methodology below.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{washer} + \Delta kWh_{DHW} + \Delta kWh_{dryer}$$

Where,

$$\Delta kWh_{washer} = Cap \times \left(\frac{F_{washer,b}}{IMEF_b} - \frac{F_{washer,q}}{IMEF_q}\right) \times N_{cycles}$$

$$\Delta kWh_{DHW} = Cap \times \left(\frac{F_{DHW,b}}{IMEF_b} - \frac{F_{DHW,q}}{IMEF_q}\right) \times N_{cycles} \times SF_{DHW,electric}$$

$$\Delta kWh_{dryer} = Cap \times \left(\frac{F_{dryer,b}}{IMEF_b} - \frac{F_{dryer,q}}{IMEF_q}\right) \times N_{cycles} \times SF_{dryer,electric}$$

Annual Fuel Savings

$$\Delta Therms = \Delta Therms_{DHW} + \Delta Therms_{dryer}$$

Where,

$$\Delta Therms_{DHW} = Cap \times \left(\frac{F_{DHW,b}}{IMEF_b} - \frac{F_{DHW,q}}{IMEF_q}\right) \times N_{cycles} \times R_q \times SF_{DHW,ff} \times 0.03412$$

$$\Delta Therms_{Dryer} = Cap \times \left(\frac{F_{dryer,b}}{IMEF_b} - \frac{F_{dryer,q}}{IMEF_q}\right) \times N_{cycles} \times SF_{dryer,ff} \times 0.03412$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-1 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{washer}	Annual electric energy savings attributed to clothes washer operation	Calculated	kWh/yr	
ΔkWh_{DHW}	Annual electric energy savings attributed to water heating	Calculated	kWh/yr	
ΔkWh_{dryer}	Annual electric energy savings attributed to dryer operation	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{DHW}$	Annual fuel savings attributed to water heating	Calculated	Therms/yr	
$\Delta Therms_{dryer}$	Annual fuel savings attributed to dryer operation	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta H2O$	Annual water savings	Calculated	Gal/yr	
Cap	Capacity of clothes washer	Site-specific. If unknown, use 3.39	ft^3	[1]
$IMEF_q$	Integrated Modified Energy Factor of efficient unit	Site-specific. If unknown, look up in Table 2-3	$ft^3/(kWh \cdot cycle)$	[2][3]
IWF_q	Integrated water factor for efficient unit	Site-specific. If unknown, look up in Table 2-8	$Gal/(cycle \cdot ft^3)$	[2][3]
$IMEF_b$	Integrated Modified Energy Factor of baseline unit	Look up in Table 2-2	$ft^3/(kWh \cdot cycle)$	[2]
N_{cycles}	Number of clothes washer cycles per year	Look up in Table 2-4	cycles	
$F_{washer,b}$	Fraction of total energy consumption attributed to clothes washer operation for the baseline case	Look up in Table 2-5	N/A	[5]
$F_{washer,q}$	Fraction of total energy consumption attributed to clothes washer operation for the efficient case	Look up in Table 2-6	N/A	[6]
$F_{DHW,b}$	Fraction of total energy consumption attributed to water heating for the baseline case	Look up in Table 2-5	N/A	[5]

Variable	Description	Value	Units	Ref
$F_{DHW,q}$	Fraction of total energy consumption attributed to water heating for the efficient case	Look up in Table 2-6	N/A	[6]
$F_{dryer,b}$	Fraction of total energy consumption attributed to dryer operation for the baseline case	Look up in Table 2-5	N/A	[5]
$F_{dryer,q}$	Fraction of total energy consumption attributed to dryer operation for the efficient case	Look up in Table 2-6	N/A	[6]
$SF_{DHW,electric}$	Electric DHW savings factor	Look up in Table 2-7	N/A	[10]
$SF_{dryer,electric}$	Electric dryer savings factor	Look up in Table 2-7	N/A	[10]
$SF_{DHW,ff}$	Fossil fuel DHW savings factor	Look up in Table 2-7	N/A	[10]
$SF_{dryer,ff}$	Fossil fuel dryer savings factor	Look up in Table 2-7	N/A	[10]
Hrs	Annual operating hours	Look up in Table 2-4	Hrs/yr	
IWF_b	Integrated water factor for baseline unit	Look up in Table 2-2	Gal/(cycle·ft^3)	
CF	Electric coincidence factor	Look up inTable 2-9	N/A	
PDF	Gas peak day factor	Look up in Table 2-9	N/A	
R_q	Recovery efficiency factor	1.26	N/A	[8]
0.03412	Unit conversion, therm/kWh	0.03412	Therm/kWh	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-2 Federal Standard Minimum IMEF and Maximum IWF

Configuration	Capacity (ft^3)	IMEF	IWF
Top Load	<1.6	1.15	12.0
Top Load	≥1.6	1.57	6.5
Front Load	<1.6	1.13	8.3
Front Load	≥1.6	1.84	4.7

Table 2-3 Efficient Unit Minimum IMEF

Efficiency Level	Front Loading	Top Loading
Clothes Washers > 2.5 ft^3		
ENERGY STAR	2.76	2.06
CEE Tier 1	2.76	2.76
CEE Tier 2	2.92	

Efficiency Level	Front Loading	Top Loading
CEE Tier 3	3.10	
Clothes Washers ≤ 2.5 ft³		
ENERGY STAR	2.07	
CEE Tier 1	2.07	
CEE Tier 2	2.20	

Table 2-4 Annual Cycles and Hours

Type	Number of Cycles	Annual Hours	Ref
Single Family	254	295	[4]

Table 2-5 Total Energy Consumption Breakdown for Baseline Case

Efficiency Level	Clothes Washer (F_{washer})	DHW (F_{DHW})	Dryer (F_{dryer})
Federal Standard	0.07	0.65	0.28

Table 2-6 Total Energy Consumption Breakdown for Efficient Case

Efficiency Level	Clothes Washer (F_{washer})	DHW (F_{DHW})	Dryer (F_{dryer})
Clothes Washers (> 2.5 ft³)			
ENERGY STAR	0.05	0.63	0.32
CEE Tier 1	0.05	0.63	0.32
CEE Tier 2	0.10	0.87	0.03
CEE Tier 3	0.10	0.87	0.03
Clothes Washers (≤ 2.5 ft³)			
CEE Tier 1	0.08	0.72	0.20
CEE Tier 2	0.08	0.72	0.20

Table 2-7 DHW and Dryer Savings Factors

Fuel	$SF_{DHW,electric}$	$SF_{dryer,electric}$	$SF_{DHW,ff}$	$SF_{dryer,ff}$
Electric	1.00	1.00	0	0
Fossil Fuel	0	0	1.00	1.00
Unknown	Look up in Appendix K: DHW and Space Heat Fuel Split, or default to 0.31	0.68	Look up in Appendix K: DHW and Space Heat Fuel Split, or default to 0.69	0.32

Table 2-8 Efficient Unit Maximum IWF

Efficiency Level	Front Loading	Top Loading
Standard Sized Clothes Washers (> 2.5 ft^3)		
ENERGY STAR	3.2	4.3
CEE Tier 1	3.2	3.2
CEE Tier 2	3.2	3.2
CEE Tier 3	3.0	3.0
Small Sized Clothes Washers (≤ 2.5 ft^3)		
ENERGY STAR	4.2	
CEE Tier 1	4.2	
CEE Tier 2	3.7	

Peak Factors

Table 2-9 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.029	[7]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Non-Energy Impacts

$$\Delta H2O = \left(IWF_b - IWF_q\right) \times Cap \times N_{cycles}$$

Measure Life

The effective useful life (EUL) is 14 years. [9]

References

[1] Based on the average clothes washer volume of all units that are ENERGY STAR qualified as of 3/17/2020.

[2] 10 CFR Subpart C of Part 430. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[3] ENERGY STAR Program Requirements Product Specification for Clothes Washers, Version 8.1. 2021. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%208.1%20Clothes%20Washer%20Final%20Specificaiton%20-%20Partner%20Commitments%20and%20Eligibility%20Criteria.pdf

[4] CEE, Residential Clothes Washer Specification (2022). *https://library.cee1.org/system/files/library/12282/CEE_ClothesWasher_Specification_17May2022.pdf*

[5] 10 CFR Subpart B of Part 430. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B

[6] The percentage of total energy consumption that is used for the machine, heating the hot water or by the dryer is different depending on the efficiency of the unit. Values are based on a weighted average of top loading and front loading units (based on available product from the ENERGY STAR qualified product list accessed on 3/17/2020) and consumption data from Life-Cycle Cost and Payback Period Excel-based analytical tool, available online at: https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&dct=SR&D=EERE2008-BT-STD-0019

[7] Navigant, EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs (2013).

[8] To account for the different efficiency of electric and fossil fuel water heaters (gas water heater: recovery efficiencies ranging from 0.74 to 0.85 (0.78 used), and electric water heater with 0.98 recovery efficiency (http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf). Therefore, a factor of 0.98/0.78 (1.26) is applied.

[9] Regulations.gov, Residential Clothes Washers Life-Cycle Cost Analysis (LCC) Spreadsheets (2021). https://www.regulations.gov/document/EERE-2017-BT-STD-0014-0025

[10] U.S. EIA 2015 Residential Energy Consumption Survey. https://www.eia.gov/consumption/residential/data/2015/

2.1.2 CLOTHES DRYER

Market	Residential/Multifamily
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Clothes Washer
Measure Last Reviewed	December 2022

Description

This measure is for a new or replacement ENERGY STAR or ENERGY STAR Most Efficient residential clothes dryer. This measure relates to the installation of a residential clothes dryer meeting the ENERGY STAR V1.1 criteria. ENERGY STAR qualified clothes dryers save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through increased insulation, modifying operating conditions such as air flow and/or heat input rate, improving air circulation through better drum design or booster fans, and improving efficiency of motors. Reducing the runtime of dryers through automatic termination by temperature and moisture sensors is believed to have the greatest potential for reducing energy use in clothes dryers. ENERGY STAR provides criteria for both gas and electric clothes dryers.

This measure can also be used for small commercial and industrial applications.

Baseline Case

The baseline for energy savings calculations is a clothes dryer meeting the federal minimum combined energy factor for machines manufactured after January 2015. The minimum combined energy factor varies by clothes dryer type.

Efficient Case

The energy consumption of the efficient equipment is calculated based on the combined energy factor of the ENERGY STAR or ENERGY STAR Most Efficient product and other variables defined in the calculation methodology.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = Cycles_{annual} \times Load \times \left(\frac{F_{elec,b}}{CEF_b} - \frac{F_{elec,q}}{CEF_q}\right)$$

Annual Fuel Savings

$$\Delta Therms = Cycles_{annual} \times Load \times \left(\frac{F_{fuel,b}}{CEF_b} - \frac{F_{fuel,q}}{CEF_q}\right) \times \frac{3{,}412}{100{,}000}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-10 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Cycles_{Annual}$	Number of dryer cycles per year	Site-specific. If unknown, use 283	Cycles	[14]
Hrs	Annual run hours of clothes dryer	Site-specific. If unknown, use 290[3]	Hrs/yr	[14][16]
Load	Average total weight of clothes per drying cycle	Look up in Table 2-11	lbs	[14]
$F_{elec,b}$	Percentage of energy consumed that is derived from electricity for baseline condition	Look up in Table 2-11	N/A	[15][16]
CEF_b	Combined energy factor for baseline condition	Look up in Table 2-11	lb/kWh	[13]
$F_{elec,q}$	Percentage of energy consumed that is derived from electricity for efficient condition	Look up in Table 2-11	N/A	[15][16]

[3] Assumes average of 56 minutes per cycle based on Ecova, 'Dryer Field Study', Northwest Energy Efficiency Alliance (NEEA) 2014.

Variable	Description	Value	Units	Ref
CEF_q	Combined energy factor for efficient case	Site-specific. If unknown, look up in Table 2-11	lb/kWh	[12]
$F_{fuel,b}$	Percentage of energy consumed that is derived from fossil fuel for baseline condition	Look up in Table 2-11	N/A	[15][16]
$F_{fuel,q}$	Percentage of energy consumed that is derived from fossil fuel for efficient case	Look up in Table 2-11	N/A	[15][16]
CF	Electric coincidence factor	Look up in Table 2-12	N/A	[15]
PDF	Gas peak demand factor	Look up in Table 2-12	N/A	
3,412	Conversion factor from kWh to Btu	3,412	Btu/kWh	
100,000	Conversion factor from Btu to therms	100,000	Btu/Therm	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-11 Default Values for Various Dryer Types

Dryer Type	Load	$F_{elec,b}$	$F_{elec,q}$	$F_{fuel,b}$	$F_{fuel,q}$	CEF_b	CEF_q (Energy Star)	CEF_q (Energy Star Most Efficient)
Vented Gas Dryer	8.45	0.16[4]	0.16	0.84[5]	0.84	3.30	3.48	
Ventless or Vented Electric, Standard ≥ 4.4 ft^3	8.45	1.00	1.00	0.00	0.00	3.73	3.93	4.3
Ventless or Vented Electric, Compact (120V) < 4.4 ft^3	3.00	1.00	1.00	0.00	0.00	3.61	3.80	4.3
Vented Electric, Compact (240V) < 4.4 ft^3	3.00	1.00	1.00	0.00	0.00	3.27	3.45	4.3
Ventless Electric, Compact (240V) < 4.4 ft^3	3.00	1.00	1.00	0.00	0.00	2.55	2.68	3.7

[4] %Electric accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc). 16% was determined using a ratio of the electric to total savings from gas dryers given by ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.

[5] %Gas accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc). 84% was determined using a ratio of the gas to total savings from gas dryers given by ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.

Peak Factors

Table 2-12 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.029	[17]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 12 years [11].

References

[11] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020.

[12] ENERGY STAR Program Requirements for Clothes Dryers. n.d. Accessed December 27, 2022. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%201.1%20Clothes%20Dryers%20Specification%20-%20Program%20Commitment%20Criteria%20and%20Eligibility%20Criteria_0.pdf

[13] PART 430 - ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS n.d. https://federalregister.gov. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#430.32

[14] *Savings Calculator for ENERGY STAR Qualified Appliances*, ENERGY STAR, 2012. https://www.sfwmd.gov/sites/default/files/documents/calculator_energy_star_res_appliance_savings.xlsx

[15] *Mid-Atlantic Technical Reference Manual (TRM) V10.* (2020). https://neep.org/sites/default/files/media-files/trmv10.pdf

[16] ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis, August 2013. https://www.energystar.gov/sites/default/files/specs/ENERGY%20STAR%20Draft%202%20Version%201.0%20Clothes%20Dryers%20Data%20and%20Analysis.xlsx

[17] Northwest Energy Efficiency Alliance (NEEA), *Dryer Field Study*, November 2014. https://ecotope-publications-database.ecotope.com/2014_005_1_DryerStudy.pdf

2.1.3 DISHWASHER

Market	Residential/Multifamily
Baseline Condition	NC/TOS
Baseline	Code
End Use Subcategory	Kitchen
Measure Last Reviewed	December 2022

Description

This measure covers the installation of ENERGY STAR® V6.0 qualified residential dishwashers. A dishwasher is a cabinet-like appliance that, with the aid of water and detergent, washes, rinses, and dries (when a drying process is included) dishware, glassware, eating utensils, and most cooking utensils by chemical, plumbing, and/or electrical means and discharges to the plumbing drainage system. ENERGY STAR® rated machines run more efficiently while washing dishes through improved technology such as soil sensors, improved water filtration, more efficient jets, and innovative dish rack designs. Qualified dishwashers are atleast 8.6% more efficient than non-certified models.

Baseline Case

The baseline condition is a residential dishwasher as defined in the Measure Description section above with type equivalent to the efficient case meeting the minimum effective federal performance standards. The baseline water heating system is a standard efficiency storage type electric or fossil fuel system (fuel type equivalent to the actual existing condition). Current federal annual energy consumption performance standards for dishwashers are provided in the table below.

Efficient Case

The compliance condition is an ENERGY STAR® V6.0 qualified residential dishwasher as defined in the Measure Description section above. Qualifying equipment must have rated annual energy consumption at or below the ENERGY STAR® qualified specifications as indicated the table below, based on dishwasher type. The energy consumption rating of the qualified dishwasher is to be taken from the application.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times (F_{machine} + F_{wh} \times ElecSF_{wh})$$

Annual Fuel Savings

$$\Delta Therms = \left(kWh_b - kWh_q\right) \times F_{wh} \times FuelSF_{wh} \times 1.307 \times \frac{3{,}412}{100{,}000}$$

Summer Peak Coincident Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-13 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_q	Annual rated electric energy use for energy efficient condition	Site-specific. If unknown, look up in Table 2-14	kWh	[24]
kWh_b	Annual rated electric energy use for baseline condition	Look up in Table 2-14	kWh	[18]
$F_{machine}$	Fraction of energy used for the dishwasher machine	0.44	N/A	[19]
F_{wh}	Fraction of energy used for the water heater	0.56	N/A	[19]
Hrs	Annual operating hours	301	Hours	[18]
$ElecSF_{wh}$	Electric Savings Factor for water heaters	Look up in Table 2-15	N/A	[21]
$FuelSF_{wh}$	Fuel Savings Factor of water heaters	Look up in Table 2-15	N/A	[21]
1.307	Ratio of recovery efficiency of electric water heater to the recovery efficiency of fossil fuel water heater	1.307	N/A	[22][18]

Variable	Description	Value	Units	Ref
3,412	Conversion factor from kWh to Btu	3,412	Btu/kWh	
100,000	Conversion factor from Btu to therms	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 2-16	N/A	
PDF	Gas peak day factor	Look up in Table 2-16	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-14 Baseline and Efficient kWh

Dishwasher Type	kWh_b	kWh_e
Compact	222	203
Standard	307	270

Table 2-15 Savings Factors

Type	Electric	Fuel
Electric WH	1.00	0
Fossil Fuel WH	0	1.00
Other	0	0
Unknown	Look up in Appendix K: DHW and Space Heat Fuel Split, or default to 0.20	Look up in Appendix K: DHW and Space Heat Fuel Split, or default to 0.54

Peak Factors

Table 2-16 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.029	[20]
Natural gas peak day factor (PDF)	Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 11 years [23].

References

[18] 10 CFR 430.32 (f)(1). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#p-430.32(f)(1) An average of 215 annual 1.4-hour dishwasher cycles is assumed in order to estimate conventional and qualifying energy ratings, for a total of 301 hours of active use per year.

[19] ENERGY STAR Residential Appliance Savings Calculator, 2012.

[20] From NY TRM v10: "Based on 8,760 end use data for Missouri, provided to VEIC by Ameren for use in the Illinois TRM. The average dishwasher load during peak hours is divided by the peak load. In the absence of a New York specific load shape, this is deemed a reasonable proxy because load shapes are not expected to vary significantly by region. Data from Ameren was adjusted to account for the difference in assumed annual operating hours (252 hours were used in the referenced study whereas 301 hours are cited in this document) and peak range was adjusted to reflect New York peak time (the hour ending in 5PM) from Illinois peak time (1PM to the hour ending 5PM)."

[21] Based on NYSERDA Residential Statewide Baseline Study of New York State – July 2015.[6] "Unknown" shall only be applied when the collection of information on water heating fuel is not feasible due to program configuration of delivery mechanism. ElecSF and FuelSF "unknown" factors may not sum to 100% due to the presence of other water heating fuels.

[22] Per 10 CFR 430 Subpart B Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters: *6.3.2 Recovery Efficiency.*

[23] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

[24] *ENERGY STAR® Program Requirements for Residential Dishwashers Eligibility Criteria Version 6.0* (2016), Table 1. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Residential%20Dishwasher%20Version%206.0%20Final%20Program%20Requirements.pdf

[6] NYSERDA Residential statewide Baseline Study. Volume 1: Single Family Report, Table 38: Water Heating Fuel Type by Climate Zone. Overall statewide averages applied. ElecSF and FuelSF "unknown" factors may not sum to 100% due to the presence of other water heating fuels. In the condition of other water heating fuels in home, the designation "Other" shall be applied.

2.1.4 INDUCTION RANGE/COOKTOP

Market	Residential/Multifamily
Baseline Condition	RF/TOS
Baseline	Existing
End Use Subcategory	Kitchen
Measure Last Reviewed	January 2023

Description

This measure is applicable to the replacement of electric resistance and fossil fuel cooktops with electric induction cooktops in single family and multifamily in-unit kitchens. Induction cooktops heat food faster, are easier to clean, are less likely to burn those using them, and have a higher cooking efficiency than electrical resistance stoves. Conventional residential cooktops typically employ fossil fuel or resistance heating elements to transfer energy, with efficiencies of approximately 32% and 75%-80% respectively. Residential induction cooking tops instead consist of an electromagnetic coil that creates a magnetic field when supplied with an electric current. When brought into this field, compatible cookware is warmed internally, transferring energy with approximately 85% efficiency. If the replacement equipment is a range or induction cooktop, the cooktop must have either 4 or 5 burners.

Baseline Case

The baseline condition is a standalone electric resistance or fossil fuel-fired cooktop.

Efficient Case

The compliance condition is an induction cooktop with compatible cookware.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kWh_b \times F_{elec,b} - kWh_q$$

Where,

$$kWh_b = 1.135 \times kWh_q$$

Annual Fuel Savings

$$\Delta Therms = Therms_b \times F_{fuel,b}$$

Where,

$$Therms_b = 2.1 \times kWh_q \times \frac{3,412}{100,000}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-17 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_b	Energy consumption by electric baseline cooktop	Site-specific, if unknown use abovementioned formulae	kWh	[25]
kWh_q	Energy consumption by induction cooktop	Site-specific, if unknown use 125 kWh	kWh	[26]
hrs	Annual operating hours	Site-specific, if unknown use 365 hours	Hours	[27]
$F_{elec,b}$	Electric factor; used to account for the presence or absence of an electric cooktop in the baseline condition	Use a value of 1.0 if the baseline cooktop is electric. Otherwise, use 0.0. If unknown, use 0.61.	N/A	[30]
$F_{fuel,b}$	Fossil fuel factor; used to account for the presence or absence of a fossil fuel-fired cooktop in the baseline condition	Use a value of 1.0 is the baseline cooktop is fossil fuel. Otherwise, use 0.0. If unknown, use 0.39.	N/A	[30]
$Therms_b$	Energy consumption by fossil fuel baseline cooktop	Site-specific, if unknown use abovementioned formulae.	Therms	[28]

Variable	Description	Value	Units	Ref
1.135	Relative efficiency of induction to resistance cooktops	1.135	N/A	[25]
2.1	Relative efficiency of induction to gas cooktops	2.1	N/A	[28]
3,412	Conversion from Btu to kWh	3,412	Btu/kWh	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
CF	Electric coincidence factor	See Table 2-18	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[29]

Peak Factors

Table 2-18 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 16 years [29].

References

[25] SWAP015-01, Induction Cooking with or without Electric Range, pg 7, May 2020. Available online at http://deeresources.net/workpapers. Based on relative efficiency of induction to resistance cooktops, 0.84/0.74 = 1.135

[26] ENERGY STAR®, Emerging Technology, 2021-2022 Residential Induction Cooking Tops, January 2023 https://www.energystar.gov/about/2021_residential_induction_cooking_tops

[27] Frontier Energy, Residential Cooktop Performance and Energy Comparison Study, Frontier Energy Report # 501318071-R0, Table 9, July 2019. https://cao-94612.s3.amazonaws.com/documents/Induction-Range-Final-Report-July-2019.pdf

[28] SWAP013-01, Residential Cooking Appliances – Fuel Substitution, pg 10; based on relative efficiency of induction to gas cooktops,0.84/0.399 = 2.1, May 2020

[29] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 10, January 2023.https://dps.ny.gov/system/files/documents/2023/03/c1e1783c-c3d3-48a4-8647-a5923c39553c.pdf.

[30] Residential Energy Consumption Survey 2015, table HC3.1

2.1.5 REFRIGERATORS

Market	Residential/Multifamily
Baseline Condition	NC/TOS/EREP/DI
Baseline	Code/Existing/Dual
End Use Subcategory	Kitchen
Measure Last Reviewed	December 2022

Description

This measure relates to the purchase and installation of a new refrigerator or refrigerator/freezer meeting either ENERGY STAR® 5.1 or Consortium for Energy Efficiency (CEE) TIER 2 or TIER 3 specifications (defined as requiring ≥10%, ≥15% or ≥ 20% less energy consumption than an equivalent unit meeting federal standard requirements respectively).

Baseline Case

Early Replacement (EREP): Early replacement uses a dual baseline. The baseline is the existing unit for the remaining life of the existing unit and the baseline is a code-compliant/standard efficiency unit for the remaining life of the installed equipment. Savings are calculated between the existing unit and the new efficient unit consumption during the assumed remaining life of the existing unit, and between a hypothetical new baseline unit and the efficient unit consumption for the remainder of the measure life.

Time of Sale (TOS) and new construction (NC): The baseline condition is a new refrigerator meeting the minimum federal efficiency standard for refrigerator efficiency as presented below.

Efficient Case

The efficient condition is a high-efficiency refrigerator meeting ENERGY STAR® 5.1 or Consortium for Energy Efficiency (CEE) TIER 2 or TIER 3 specifications requirements.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times (1 + HVAC_c) \times F_{occ}$$

Annual Fuel Savings

$$\Delta Therms = \left(kWh_b - kWh_q\right) \times HVAC_{ff} \times F_{occ} \times 10$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{kWh_b - kWh_q}{8{,}760}\right) \times (1 + HVAC_d) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-19 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings for	Calculated	kWh/yr	
ΔTherms	Annual fuel savings for Time of Sale	Calculated	Therms/yr	
$\Delta kW_{Peak,}$	Peak Demand Savings for Time of Sale	Calculated	kWr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
AV	Adjusted volume of refrigerator	Site-specific	ft^3	
kWh_q	Annual energy consumption of qualifying efficiency unit	Site-specific, if unknown look up in Table 2-20 for ENERGY STAR specifications and Table 2-21 for CEE specifcationsTable 2-20	kWh/yr	[32][35]

Variable	Description	Value	Units	Ref
kWh_b	Annual energy consumption of code-compliant baseline unit	Site-specific,[7] if unknown look up in Table 2-20	kWh/yr	[31]
F_{occ}	Adjustment factor to account for number of occupants	Look up in Table 2-28, if unknown use 1.0	N/A	[33]
CF	Electric coincidence factor	Loo kup in Table 2-23	N/A	
PDF	Gas peak day factor	Loo kup in Table 2-23	N/A	
$HVAC_c$	HVAC interaction factor for annual electric energy consumption	0.080. If unconditioned space, use 0	N/A	
$HVAC_d$	HVAC interaction factor for peak demand at utility summer peak hour	0.175. If unconditioned space, use 0	N/A	
$HVAC_{ff}$	HVAC interaction factor for annual fossil fuel energy consumption	-0.002. If unconditioned space or electric heat use 0	MMBtu/kWh	
8,760	Hours per year	8,760	Hrs/yr	
10	Unit conversion, Therm/MMBtu	10	Therms/MMBtu	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 2-20 Federal Standard and ENERGY STAR Refrigerator Maximum Annual Energy Consumption

Product Category	Federal Baseline Maximum Energy Usage, kWh_b	ENERGY STAR Maximum Energy Usage, kWh_q
Standard Size Models: 7.75 cubic feet or greater		
1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost.	$7.99 \times AV + 225.0$	$7.19 \times AV + 202.5$
1A. All-refrigerators—manual defrost.	$6.79 \times AV + 193.6$	$6.11 \times AV + 174.2$
2. Refrigerator-freezers—partial automatic defrost	$7.99 \times AV + 225.0$	$7.19 \times AV + 202.5$
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker.	$8.07 \times AV + 233.7$	$7.26 \times AV + 210.3$
3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker.	$9.15 \times AV + 264.9$	$8.24 \times AV + 238.4$
3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	$8.07 \times AV + 317.7$	$7.26 \times AV + 294.3$

[7] NC/TOS: look up code efficiency. EREP/DI: use existing unit. The Annual Energy Consumption of existing unit can be determined in preference order of: 1) Field measurement 2) EnergyGuide Label on the equipment 3) Manufacturer Rated kWh Usage 4) Residential Appliance Recycling measure

Product Category	Federal Baseline Maximum Energy Usage, kWh_b	ENERGY STAR Maximum Energy Usage, kWh_q
3I-BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	$9.15 \times AV + 348.9$	$8.24 \times AV + 322.4$
3A. All-refrigerators—automatic defrost.	$7.07 \times AV + 201.6$	$6.36 \times AV + 181.4$
3A-BI. Built-in All-refrigerators—automatic defrost.	$8.02 \times AV + 228.5$	$7.22 \times AV + 205.7$
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	$8.51 \times AV + 297.8$	$7.66 \times AV + 268.0$
4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	$10.22 \times AV + 357.4$	$9.20 \times AV + 321.7$
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	$8.51 \times AV + 381.8$	$7.66 \times AV + 352.0$
4I-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	$10.22 \times AV + 441.4$	$9.20 \times AV + 405.7$
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	$8.85 \times AV + 317.0$	$7.97 \times AV + 285.3$
5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	$9.40 \times AV + 336.9$	$8.46 \times AV + 303.2$
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	$8.85 \times AV + 401.0$	$7.97 \times AV + 369.3$
5I-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	$9.40 \times AV + 420.9$	$8.46 \times AV + 387.2$
5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	$9.25 \times AV + 475.4$	$8.33 \times AV + 436.3$
5A-BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	$9.83 \times AV + 499.9$	$8.85 \times AV + 458.3$
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service.	$8.40 \times AV + 385.4$	$7.56 \times AV + 355.3$
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	$8.54 \times AV + 432.8$	$7.69 \times AV + 397.9$
7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	$10.25 \times AV + 502.6$	$9.23 \times AV + 460.7$
Compact Size Models: Less than 7.75 cubic feet		
11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost.	$9.03 \times AV + 252.3$	$8.13 \times AV + 227.1$
11A.Compact all-refrigerators—manual defrost.	$7.84 \times AV + 219.1$	$7.06 \times AV + 197.2$

Product Category	Federal Baseline Maximum Energy Usage, kWh_b	ENERGY STAR Maximum Energy Usage, kWh_q
12. Compact refrigerator-freezers—partial automatic defrost	$5.91 \times AV + 335.8$	$5.32 \times AV + 302.2$
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer.	$11.80 \times AV + 339.2$	$10.62 \times AV + 305.3$
13I. Compact refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker.	$11.80 \times AV + 423.2$	$10.62 \times AV + 389.3$
13A. Compact all-refrigerators—automatic defrost.	$9.17 \times AV + 259.3$	$8.25 \times AV + 233.4$
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer.	$6.82 \times AV + 456.9$	$6.14 \times AV + 411.2$
14I. Compact refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker.	$6.82 \times AV + 540.9$	$6.14 \times AV + 495.2$
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer.	$11.80 \times AV + 339.2$	$10.62 \times AV + 305.3$
15I. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker.	$11.80 \times AV + 423.2$	$10.62 \times AV + 389.3$

Where $AV = fresh\ volume + (1.63 \times freezer\ volume)$

Table 2-21 CEE Residential Refrigerator Efficiency Specification

Efficiency Level	Percent Improvement Over Measured[8] Federal Minimum Efficiency Standard
CEE Tier 1[9]	10
CEE Tier 2	15
CEE Tier 3	30

Table 2-22 Occupant Adjustment Factor

Number of Occupants	F_{occ}
0	1.00
1	1.05
2	1.10
3	1.13
4	1.15
5 or more	1.16

[8] Measure Minimum Efficiency Standard is defined as the measured energy consumption of the refrigerator according to the DOE test method, prior to the application of any adder (84 kWh/yr) for automatic icemakers. For refrigerators with automatic icemakers, the percentage improvement is calculated by dividing the difference in annual energy use by the minimum efficiency standard, less the 84 kWh/yr adder.
[9] CEE Tier 1 is aligned with the ENERGY STAR Version 5.1 specifcation for resendential refrigerators.

Number of Occupants	F_{occ}
Unknown	1.00

Peak Factors

Table 2-23 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-24 Measure Life

Equipment	EUL	RUL	Ref
Refrigerator	12	4	[34]

References

[31] 10 CFR Subpart C of Part 430, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[32] ENERGY STAR Program Requirements Product Specifications for Residential Refrigerators and Freezers Version 5.1. Effective 9/15/2014. https://www.energystar.gov/sites/default/files/asset/document/Refrigerators_and_Freezers_Program_Requirements_V5.1.pdf

[33] The Occupant Adjustment Factor is developed from simulating audits within the Oak Ridge National Laboratory, National Energy Audit Tool (NEAT), 2012. https://weatherization.ornl.gov/obtain/

[34] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx. Accessed December 2022.

[35] CEE, 2022 CEE Home Appliances Initiative and Residential Refrigerator Specification, May 2022 https://library.cee1.org/content/cee-residential-refrigerator-specification

2.1.6 FREEZER

Market	Residential/Multifamily
Baseline Condition	NC/TOS/RF/EREP
Baseline	Code/Existing/Dual
End Use Subcategory	Kitchen
Measure Last Reviewed	December 2022

Description

This measure relates to the promotion of residential freezers meeting the ENERGY STAR 5.1 criteria through retail channels and through upstream efforts such as the ENERGY STAR Retail Products Program. In the measure, a freezer meeting the efficiency specifications of ENERGY STAR is installed in place of a model meeting the federal standard (NAECA). Energy usage specifications are defined in the tables below. Freezer adjusted volume used in the specifications is calculated as follows:

$$AV = 1.76 \times (total\ freezer\ volume)$$

Baseline Case

The baseline equipment is assumed to be a freezer model that meets the federal minimum standard for energy efficiency. The standard varies depending on the type of the freezer (chest or upright freezer), its size category (full or compact) and other attributes (defrost type and presence of through the door ice) and is defined in the tables below.

Efficient Case

The efficient equipment is defined as a freezer meeting the freezer efficiency specifications of ENERGY STAR v 5.1, as calculated below.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = (kWh_b - kWh_q) \times (1 + HVAC_c) \times F_{occ}$$

Annual Fuel Savings

$$\Delta Therms = (kWh_b - kWh_q) \times HVAC_{ff} \times F_{occ} \times 10$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{kWh_b - kWh_q}{8{,}760}\right) \times (1 + HVAC_d) \times TAF \times LSAF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-25 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_b	kWh consumption for basline case	Look up in Table 2-26, if volume unknown use Table 2-27	kWh/yr	[36]
kWh_q	kWh consumption for energy efficient case	Site-specific, if unknown look up in Table 2-26. If volume unknown use Table 2-27	kWh/yr	[37]

Variable	Description	Value	Units	Ref
F_{occ}	Adjustment factor to account for number of occupants	Look up in Table 2-28. If unknown use 1.0	N/A	[42]
$HVAC_c$	HVAC interaction factor for annual electric energy consumption	0.080. If unconditioned space use 0	N/A	[43]
$HVAC_d$	HVAC interaction factor for peak demand at utility summer peak hour	0.175. If unconditioned space use 0	N/A	[43]
$HVAC_{ff}$	HVAC interaction factor for annual fossil fuel energy consumption	-0.002. If unconditioned space use 0	MMBtu/kWh	
TAF	Temperature Adjustment Factor	1.23	N/A	[39]
LSAF	Load Shape Adjustment Factor	1.15	N/A	[40]
CF	Electric coincidence factor	Look up in Table 2-29	N/A	
PDF	Gas peak day factor	Look up in Table 2-29	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life	See Measure Life Section	Years	

Table 2-26 Freezer Baseline and Efficient Annual kWh Consumption

Product Class	Baseline Annual kWh Consumption (kWh_b) [36]	Energy Efficient Annual kWh Consumption (kWh_q) [37]
Full-Size Freezers, where AV is adjusted volume		
8. Upright freezers with manual defrost	$5.57 \times AV + 193.7$	$5.01 \times AV + 174.3$
9. Upright freezers with automatic defrost without an automatic icemaker	$8.62 \times AV + 228.3$	$7.76 \times AV + 205.5$
9I. Upright freezers with automatic defrost with an automatic icemaker	$8.62 \times AV + 312.3$	$7.76 \times AV + 289.5$
9-BI. Built-In upright freezers with automatic defrost without an automatic icemaker	$9.86 \times AV + 260.9$	$8.87 \times AV + 234.8$
9I-BI. Built-in upright freezers with automatic defrost with an automatic icemaker	$9.86 \times AV + 344.9$	$8.87 \times AV + 318.8$
10. Chest freezers and all other freezers except compact freezers	$7.29 \times AV + 107.8$	$6.56 \times AV + 97.0$
10A. Chest freezers with automatic defrost	$10.24 \times AV + 148.1$	$9.22 \times AV + 133.3$
Compact Freezers, where AV is adjusted volume		
16. Compact upright freezers with manual defrost	$8.65 \times AV + 225.7$	$7.79 \times AV + 203.1$
17. Compact upright freezers with automatic defrost	$10.17 \times AV + 351.9$	$9.15 \times AV + 316.7$

Product Class	Baseline Annual kWh Consumption (kWh_b) [36]	Energy Efficient Annual kWh Consumption (kWh_q) [37]
18. Compact chest freezers	$9.25 \times AV + 136.8$	$8.33 \times AV + 123.1$

If freezer volume is unknown, use the default consumption values in Table 2-27.

Table 2-27 Default Values

Product Category	AV (assumed)	kWh_b	kWh_q	Market Share Weighting [38]
Upright Freezer	24.4	439	395	36.74%
Chest Freezer	18.0	239	215	63.26%
Weighted Average		313	281	100%

Table 2-28 Occupant Adjustment Factor

Number of Occupants	F_{occ}
Unknown	1.00
1	1.05
2	1.10
3	1.13
4	1.15
5 or more	1.16

Peak Factors

Table 2-29 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-30 Measure Life

Equipment	EUL	RUL	Ref
Freezer	11	3.66	[41]

References

[36] "Electronic Code of Federal Regulations (ECFR)." 2020. https://www.ecfr.gov/cgi-bin/

[37] "ENERGY STAR Program Requirements for Residential Refrigerators and Freezers Partner Commitments." https://www.energystar.gov/ia/partners/product_specs/program_reqs/Refrigerators_and_Freezers_Program_Requirements_V5.0.pdf.

[38] The weighted average unit energy savings is calculated using the market share of upright and chest freezers. The assumed market share, as presented in the table above, comes from 2011 NIA-Frz-2008 Shipments data.

[39] Temperature adjustment factor based on Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report 2003-2004 Metering Study", July 29, 2004 (p.47) and assuming 78% of refrigerators are in cooled space (based on BGE Energy Use Survey, Report of Findings, December 2005; Mathew Greenwalk & Associates) and 22% in un-cooled space. Although this evaluation is based upon refrigerators only it is considered a reasonable estimate of the impact of cycling on freezers and gave exactly the same result as an alternative methodology based on Freezer eShape data.

[40] Daily load shape adjustment factor also based on Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study", July 29, 2004 (p. 48), (extrapolated by taking the ratio of existing summer to existing annual profile for hours ending 15 through 18, and multiplying by new annual profile).

[41] ENERGY STAR assumes 11 years based on Appliance Magazine U.S. Appliance Industry: Market Value, Life Expectancy & Replacement Picture for 2005-2012, 2011.

[42] The Occupant Adjustment Factor is developed from simulating audits within the ORNL weatherization tool, National Energy Audit Tool (NEAT), Oak Ridge National Laboratory, 2012.

[43] From NY TRM V10, Pg 1162

2.1.7 WATER COOLER

Market	Residential/Multifamily
Baseline Condition	NC/TOS
Baseline	Code
End Use Subcategory	Kitchen
Measure Last Reviewed	December 2022

Description

This measure estimates savings for installing ENERGY STAR Water Coolers compared to standard efficiency equipment in residential applications. The measurement of energy and demand savings is based on a deemed savings value multiplied by the quantity of the measure.

Baseline Case

Residential water cooler meeting Energy Star v. 2.0 Water Cooler requirements as directed by N.J. PL 2021, c. 464.

Efficient Case

ENERGY STAR v. 3.0 compliant residential water cooler.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times 365$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hr} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-31 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Hr	Annual hours of operation	Site-specific. If unknown, assume 8,760	Hrs	
kWh_b	Energy use of baseline water cooler	Look up in Table 2-32	kWh/day	[44]
kWh_q	Energy use of energy efficient water cooler	Site-specific. If unknown, look up in Table 2-32	kWh/day	[45]
CF	Electric coincidence factor	Look up in Table 2-33	N/A	
PDF	Gas peak day factor	Look up in Table 2-33	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-32 Water Cooler Energy Use

Energy Star Water Cooler Type Product Capacity Class, and Conditioning Method	Baseline kWh_b (kWh/day)	Default Efficient kWh_q (kWh/day)
Cold Only	0.16	0.16
Hot & Cold – Low Capacity[10]	0.87	0.68
Hot & Cold – High Capacity[11]	0.87	0.80
Hot & Cold On-Demand	0.18	0.18

[10] A water cooler with a cold-water dispenser capacity of 0.50 gallons per hour or less, as measured per ANSI/ASHRAE Standard 18. For units that also provide hot water, the unit must have a hot-water dispenser capacity that is equal to or less than 41 exact 6 oz. cups per hour, as rated per ANSI/ASHRAE Standard 18.

[11] A water cooler with a cold-water dispenser capacity that is greater than 0.50 gallons per hour, as measured per ANSI/ASHRAE Standard 18. For units that also provide hot water, the unit must have a hot-water dispenser capacity greater than 41 exact 6 oz. cups per hour, as rated per ANSI/ASHRAE Standard 18.

Peak Factors

Table 2-33 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	[46]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years. [44]

References

[44] ENERGY STAR Product Specification for Water Coolers Version 2.0. https://www.energystar.gov/sites/default/files/specs//ES%20WC%20V2%200%20Spec.pdf

[45] ENERGY STAR Product Specifications for Water Coolers Version 3.0. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Verison%203.0%20Water%20Coolers%20Final%20Specification_0.pdf

[46] Assumes 24/7 operation. Site-specific load shape information should be used if known.

2.1.8 AIR PURIFIER

Market	Residential/Multifamily
Baseline Condition	TOS
Baseline	ISP
End Use Subcategory	Indoor Environment
Measure Last Reviewed	December 2022

Description

An air purifier (cleaner) meeting the efficiency specifications of ENERGY STAR is purchased and installed in place of a model meeting the New Jersey P.L. 2021, c. 464 minimum standards. Compliance with this standard will start on January 1, 2023. The Coincidence factor (CF) assumes that the purifier usage is evenly spread throughout the year and the annual active operating hours assume that the air purifier operates 16 hours a day for 365 days[50].

Baseline Case

The baseline equipment is assumed to be a conventional non-ENERGY STAR unit, meeting the New Jersey P.L. 2021, c. 464 minimum standards.

Efficient Case

The efficient equipment is defined as an air purifier meeting the efficiency specifications of ENERGY STAR Version 2.0. Certified air cleaner models shall produce a minimum 30 CADR for Smoke to be considered under this specification.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

Where,

$$kWh_b = Hrs \times \left(\frac{CADR_b}{CADR\_per\_watt_b \times 1{,}000}\right) + (8{,}760 - Hrs) \times \frac{PartialPower_b}{1{,}000}$$

$$kWh_q = Hrs \times \left(\frac{CADR_q}{CADR\_per\_watt_q \times 1{,}000}\right) + (8{,}760 - Hrs) \times \frac{PartialPower_q}{1{,}000}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-34 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kWh_b	Annual electric consumption of the baseline case	Calculated	kWh/yr	
kWh_q	Annual electric consumption of the efficient case	Calculated	kWh/yr	
$CADR_b$	Clean Air Delivery Rate (CADR) for baseline air purifier	Look up in Table 2-35	cfm	[47]
$CADR\_per\_watt_b$	Clean Air Delivery Rate (CADR) per watt for baseline air purifier	Look up in Table 2-35	cfm/Watt	[47]
$PartialPower_b$	Partial On Mode Power for baseline air purifier by category	Look up in Table 2-35	Watts	[47]
$CADR_q$	Clean Air Delivery Rate (CADR) for efficient air purifier	Site-specific. If unknown, look up in Table 2-36	cfm	[48]
$CADR\_per\_watt_q$	Clean Air Delivery Rate (CADR) per watt for efficient air purifier	Site-specific. If unknown, look up in Table 2-36	cfm/watt	[48]
$PartialPower_q$	Partial On Mode Power for efficient air purifier by category	Site-specific. If unknown, look up in Table 2-36	Watts	[48]

Variable	Description	Value	Units	Ref
Hrs	Annual active operating hours	5,840	Hrs	[50]
CF	Electric coincidence factor	Look up in Table 2-39	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
1,000	Conversion from Watts to kW	1,000	Watts/kW	
8,760	Hours per year	8,760	Hours	

Table 2-35 Baseline Air Purifier Specifications

Clean Air Delivery Rate (CADR) Range	CADR used indeemed savings calculation	CADR per Watt	Partial On Mode Power with WiFi connection (Watts)	Partial On Mode Power without WiFi connection (Watts)
30 ≤ CADR < 100	75	1.7	2	1
100 ≤ CADR < 150	125	1.9	2	1
150 ≤ CADR < 200	175	2.0	2	1
200 ≤ CADR < 250	225	2.0	2	1
CADR ≥ 250	275	2.0	2	1

Table 2-36 Efficient Air Purifier Specifications

Clean Air Delivery Rate (CADR) Range	CADR used in deemed savings calculation	Minimum Smoke CADR per Watt	Maximum Partial On Mode Power with WiFi connection (watts)	Maximum Partial On Mode Power without WiFi connection (watts)
51 ≤ CADR < 100	75	1.9	2	1
101 ≤ CADR < 150	125	2.4	2	1
151 ≤ CADR < 200	175	2.9	2	1
201 ≤ CADR < 250	225	2.9	2	1
CADR ≥ 250	275	2.9	2	1

Table 2-37 Deemed kWh Savings

Clean Air Delivery Rate (CADR) Range	CADR used in deemed savings calculation	kWh Savings	
		Maximum Partial On Mode Power with WiFi connection	Maximum Partial On Mode Power without WiFi connection
51 ≤ CADR < 100	75	27	27
101 ≤ CADR < 150	125	80	80
151 ≤ CADR < 200	175	159	159
201 ≤ CADR < 250	225	204	204
CADR ≥ 250	275	249	249

Table 2-38 Deemed kW Savings

Clean Air Delivery Rate (CADR) Range	CADR used in deemed savings calculation	kW Savings	
		Maximum Partial On Mode Power with WiFi connection	Maximum Partial On Mode Power without WiFi connection
51 ≤ CADR < 100	75	0.0031	0.0031
101 ≤ CADR < 150	125	0.0091	0.0091
151 ≤ CADR < 200	175	0.0181	0.0181
201 ≤ CADR < 250	225	0.0233	0.0233
CADR ≥ 250	275	0.0285	0.0285

Peak Factors

Table 2-39 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.667[12]	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 9 years [49].

[12] Assumes equal likelihood of usage at any time of day (16/24 hours)

References

[47] "New Jersey A5160 | 2020-2021 | Regular Session." n.d. LegiScan. Accessed December 21, 2022. https://legiscan.com/NJ/text/A5160/2020

[48] "ENERGY STAR Program Requirements for Room Air Cleaners -Partner Commitments ENERGY STAR ® Program Requirements for Room Air Cleaners Partner Commitments, Version 2.0 Rev. May 2002." n.d. Accessed December 21, 2022. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%202.0%20Room%20Air%20Cleaners%20Specification%20%28Rev.%20May%202022%29.pdf

[49] EPA, Consumer Messaging Guide for Energy Star Certified Appliances. August 2018. https://www.energystar.gov/sites/default/files/asset/document/ES_Consumer_Messaging_Guide_2018_508-c.pdf

[50] "ENERGY STAR Appliance Calculator". https://www.energy.gov/energysaver/maps/appliance-energy-calculator. n.d. Accessed December 21, 2022.

2.1.9 DEHUMIDIFIER

Market	Residential/Multifamily
Baseline Condition	TOS/NC
Baseline	Code /ISP
End Use Subcategory	Indoor Environment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of residential stand-alone or whole-house dehumidifiers meeting the minimum qualifying efficiency standards established under the ENERGY STAR® Program, Version 5.0, effective October 31, 2019. This measure is restricted to dehumidifiers with a product moisture removal capacity of less than or equal to 185 pints/day.

Baseline Case

The baseline condition is a stand-alone or whole-house dehumidifier meeting the minimum effective federal standard for performance.

Dehumidifiers manufactured and distributed in commerce on or after June 13, 2019, must meet the energy conservation standards, rated in Integrated Energy Factor as specified in the Code of Federal Regulations.

Efficient Case

The compliance condition is an ENERGY STAR® v. 5 qualified stand-alone or whole-house dehumidifier.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{pints/day \times 0.473 \times hrs}{24} \times \left(\frac{1}{IEF_b} - \frac{1}{IEF_q}\right)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-40 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Pints/day	Product capacity to remove moisture	Site-specific	(pints/day)	
hrs	Annual run hours of dehumidifier	2,160	Hrs	[51]
IEF_b	Baseline Integrated Energy Factor	Look up in Table 2-41, Table 2-42	liters/kWh	[52]
IEF_q	Energy Efficient Integrated Energy Factor	Site-specific. If unknown, look up in Table 2-43, Table 2-44	liters/kWh	[53]
0.473	Conversion factor from liters to pint	0.473	liters/pint	
24	Hours in one day	24	N/A	
CF	Electric coincidence factor	Look up in Table 2-45	N/A	[54]
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-41 Stand-Alone Dehumidifiers Baseline Integrated Energy Factor

Product Capacity (pints/day)	Integrated Energy Factor (liters/kWh)
≤ 25.00	1.30
25.01 to 50.00	1.60
≥50.01	2.80

Table 2-42 Whole-House Dehumidifiers Baseline Integrated Energy Factor

Product Case Volume (ft³)	Integrated Energy Factor (liters/kWh)
≤ 8.0	≥1.77
> 8.0	≥2.41

Table 2-43 Stand-Alone Dehumidifiers Energy Efficient Integrated Energy Factor

Product Capacity (pints/day)	Integrated Energy Factor (liters/kWh)
≤ 25.00	≥1.57
25.01 to 50.00	≥1.80
≥50.01	≥3.30

Table 2-44 Whole-House Dehumidifiers Energy Efficient Integrated Energy Factor

Product Case Volume (ft³)	Integrated Energy Factor (liters/kWh)
≤ 8.0	≥2.09
> 8.0	≥3.30

Peak Factors

Table 2-45 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.405	[54]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 12 years[55].

References

[51] ACEEE, Lauren Mattison and Dave Korn, The Cadmus Group, Inc.,"Dehumidifiers: A Major Consumer of Residential Electricity", 2012, https://www.aceee.org/files/proceedings/2012/data/papers/0193-000291.pdf

[52] 10 CFR 430.32(v)(2), January 2023 https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32#p-430.32(v)(2)

[53] ENERGY STAR® Program Requirements Product Specification for Dehumidifiers, Eligibility Criteria Version 5.0, October 2019

[54] Dehumidifier Metering in PA and Ohio by ADM from 7/17/2013 to 9/22/2013. 31 Units metered. Assumes all non-coincident peaks occur within window and that the average load during this window is representative of the June PJM days as well.
[55] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 10, January 2023.

2.1.10 ROOM AIR CONDITIONER

Market	Residential/Multifamily
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Indoor Environment
Measure Last Reviewed	December 2022

Description

This measure relates to the purchase and installation of a room air conditioner that meets or exceeds the current ENERGY STAR 4.2 efficiency standards. A room air conditioner is powered by a single phase electric current and is an encased assembly designed as a unit for mounting in a window or through the wall. Qualifying units may be cooling only (non-reverse cycle) or provide cooling, heating, and ventilation. Only cooling energy savings are calculated in this measure.

Note that if the AC unit is connected to a network in a way so as to enable it to respond to energy related commands, there is a 5% extra CEER allowance. In these instances, the default baseline CEER would be 0.95 multiplied by the appropriate CEER from Table 2-47.

Baseline Case

The baseline condition is a room AC unit that meets the minimum federal efficiency standards [56] of the combined energy efficiency ratio based on the installed unit size and type.

Efficient Case

The efficient condition is a room air conditioner that meets or exceeds current ENERGY STAR specifications (version 4.2) [57]. The CEER for the efficient case should use site-specific information. If site-specific information is unknown, then default values may be used.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{Cap}{1,000} \times \left(\frac{1}{CEER_b} - \frac{1}{CEER_q}\right) \times EFLH_c$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{Cap}{1{,}000} \times \left(\frac{1}{CEER_b} - \frac{1}{CEER_q}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-46 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Cap	Capacity of energy efficient equipment	Site-specific	Btu/hr	
$CEER_q$	Combined Energy Efficiency Ratio of ENERGY STAR unit in Btus per Watt-hour	Site-specific. If unknown, look up in Table 2-47	Btu/Wh	[60]
$CEER_b$	Combined Energy Efficiency Ratio of baseline unit in Btus per Watt-hour	Look up in Table 2-47, if unknown use 11.0[13]	Btu/Wh	[56]
$EFLH_c$	Cooling equivalent full-load hours	600	Hours	[62]
1,000	Conversion from W to kW	1,000	W/kW	
CF	Electric coincidence factor	Look up in Table 2-48	N/A	[61]
EUL	Effective useful life	See Measure Life Section	Years	

[13] Default value (11.0) is the CEER value from minimum Federal Standard for the most common room AC type – <8000 capacity range with louvered sides [59]

Table 2-47 Standard and ENERGY STAR CEER Values for Room Air Conditioner

Product Type and Class (Btu/hour)		Federal standard with louvered sides ($CEER_b$)	Federal standard without louvered sides ($CEER_b$)	ENERGY STAR with louvered sides ($CEER_q$)	ENERGY STAR without louvered sides ($CEER_q$)
Without reverse cycle	<6,000	11.0	10.0	12.1	11.0
	6,000 to 7,999	11.0	10.0	12.1	11.0
	8,000 to 10,999	10.9	9.6	12.0	10.6
	11,000 to 13,999	10.9	9.5	12.0	10.5
	14,000 to 19,999	10.7	9.3	11.8	10.2
	20,000 to 27,999	9.4	9.4	10.3	10.3
	≥28,000	9.0	9.4	9.9	10.3
With reverse cycle	<14,000		9.3		10.2
	≥14,000		8.7		9.6
	<20,000	9.8		10.8	
	≥20,000	9.3		10.2	
Casement-only		9.5		10.5	
Casement slider		10.4		11.4	

Peak Factors

Table 2-48 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.31	[61]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 12 years. [58]

References

[56] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430, Subpart C, section 430.32 b) Room Air Conditioners. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[57] "ENERGY STAR Program Requirements for Room Air Conditioners -Eligibility Criteria ENERGY STAR ® Program Requirements Product Specification for Room Air Conditioners Eligibility Criteria Draft Version 4.2." n.d. Accessed January 9, 2023. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Draft%20Version%204.2%20Room%20Air%20Conditioners%20Specification_0_0.pdf
[58] GDS Associates, Inc. 2007. *Review of Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM)*. Https://Library.cee1.org. June 2007. https://library.cee1.org/system/files/library/8842/CEE_Eval_MeasureLifeStudyLights%2526HVACGDS_1Jun2007.pdf
[59] NEEP, Mid-Atlantic Technical Reference Manual, V10. pp 70-71., April 2020, https://neep.org/sites/default/files/media-files/trmv10.pdf
[60] "Room Air Conditioners Key Product Criteria." n.d. www.energystar.gov. Accessed January 10, 2023. https://www.energystar.gov/products/heating_cooling/air_conditioning_room/key_product_criteria.
[61] RLW Analytics. 2008. *Review of Coincidence Factor Study Residential Room Air Conditioners*. Puc.nh.gov. June 2008. https://www.puc.nh.gov/electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/124_SPWG%20Room%20%20AC%20Evaluation%20FINALReport%20June%2023%20ver7.pdf.
[62] VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.

2.2 APPLIANCE RECYCLING

2.2.1 REFRIGERATOR & FREEZER RECYCLING

Market	Residential
Baseline Condition	ERET
Baseline	Existing
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

In many cases, when a refrigerator or freezer is replaced by a homeowner, the existing unit is retained, sold, or donated for use elsewhere, representing additional load on the grid. This measure covers recycling of the existing, functional equipment, thereby eliminating the consumption associated with that equipment. Refrigerator and freezer recycling programs (also called “bounty” programs) receive energy savings credit for permanently removing inefficient, functional refrigerators and freezers from the electric grid.

This measure covers the recycling of primary (i.e., installed in a kitchen) and secondary[14] (i.e., installed elsewhere) refrigerators, refrigerator-freezers and freezers. To account for the fact that secondary equipment is occasionally installed and operating for only part of the year, a part-time use adjustment factor has been developed and embedded within the gross savings estimate for secondary units to establish average annual per unit deemed electric savings.

This measure does not cover the recycling of equipment classified by the Code of Federal Regulations as “Compact refrigerator/refrigerator-freezer/freezer”. This refers to any refrigerator, refrigerator-freezer or freezer with a total refrigerated volume of less than 7.75 ft3 (220 liters), where the total refrigerated volume has been determined in accordance with the procedure prescribed in Appendix A (refrigerators and refrigerator-freezers) or B (freezers) of 10 CFR 430 Subpart B.112.

Baseline Case

The savings calculations below apply to recycling of a functioning primary or secondary refrigerator, refrigerator-freezer, or freezer with total refrigerated volume of 7.75 ft3 (220 liters) or more.

Efficient Case

The compliance condition is the recycling of an existing room refrigerator or freezer as defined in the Measure Description section above.

[14] Secondary refrigerators are spare or backup refrigerators not installed in the kitchen.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{\Delta kWh}{unit}\right)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{\Delta kW}{unit}\right)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \mathrm{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-49 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔkWh/unit	Energy Savings per unit	Look up in Table 2-50	kWh	[64]
ΔkW/unit	Demand Savings per unit	Look up in Table 2-50	kWh	[64]
CF	Electric coincidence factor	Look up in Table 2-51	N/A	
PDF	Gas peak demand factor	Look up in Table 2-51	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[63]

Table 2-50 Default Values for Annual Energy and Peak Demand Savings

	Primary Refrigerator	Secondary Refrigerator	Freezer
ΔkWh/unit	958	581	593
ΔkW/unit	0.15	0.10	0.10

Peak Factors

Table 2-51 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 5 years for a refrigerator and 4 years for a freezer [63].

References

[63] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[64] DNV, Appliance Recycling Program Impact Evaluation Study, June 2021 https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BE846898E-5EAE-4F42-9F97-385982740AC6%7D

2.2.2 ROOM AC UNIT RECYCLING

Market	Residential
Baseline Condition	ERET
Baseline	Existing
End Use Subcategory	Recycling
Measure Last Reviewed	January 2023

Description

This measure describes the savings resulting from implementing a drop off service taking existing working inefficient Room Air Conditioner units from service, prior to their natural end of life. Like the Refrigerator Early Retirement / Recycling measure, this measure quantifies savings associated with the removal of room air conditioner units from service (rather than transferred to another location in the home or another household) and thus does not decrement savings due to retired units that are replaced in participants' homes. A room air conditioner is an appliance, other than a "packaged terminal air conditioner," which is powered by a single-phase electric current and that is an encased assembly designed as a unit for mounting in a window or through the wall for the purpose of providing delivery of conditioned air to an enclosed space.

Baseline Case

The baseline condition is the existing inefficient room air conditioning unit.

Efficient Case

The existing room air conditioning unit is removed from service and dismantled/recycled.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{Hrs \times Btuh \times (1/EER_{exist})}{1{,}000} \times Part\ Use\ Factor$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-52 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Hrs	Run hours of window AC unit	600	Hours	[62]
Btuh	Capacity of replaced unit	Site-specific, if unknown assume 7,829	Btu/hr	[67]
EER_{exist}	Efficiency of existing unit	Site-specific, if unknown assume 9.8	Btu/W/hr	[68]
Part Use Factor	Fraction of those units that are not in daily use throughout the entire cooling season as reported by the participant	Site-specific, if unknown use 0.34	N/A	[70]
CF	Electric coincidence factor	Look up in Table 2-53	N/A	
PDF	Gas peak day factor	Look up in Table 2-53	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 2-53 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.3	[69]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 3 years. [65]

References

[65] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx .

[66] VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.

[67] RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners (June 23, 2008 p. 22), based on population average. https://www.puc.nh.gov/electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/124_SPWG%20Room%20%20AC%20Evaluation%20FINALReport%20June%2023%20ver7.pdf

[68] Minimum Federal Standard for most common room AC type (8000-14,999 capacity range with louvered sides) per federal standards from 10/1/2000 to 5/31/2014.

[69] RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners (June 23, 2008 p. 32), CF value for Hartford, CT. https://www.puc.nh.gov/electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/124_SPWG%20Room%20%20AC%20Evaluation%20FINALReport%20June%2023%20ver7.pdf

[70] Source: Cadmus analysis, EmPOWER 2018 P1 & P2 ARP participant survey

2.2.3 DEHUMIDIFIER RECYCLING

Market	Residential
Baseline Condition	ERET
Baseline	Existing
End Use Subcategory	Dehumidifier
Measure Last Reviewed	January 2023

Description

In many cases, when homeowner replaces a dehumidifier, the existing unit is retained, sold, or donated for use elsewhere, representing additional load on the grid. This measure covers recycling of existing, functional, portable dehumidifiers, thereby eliminating the consumption associated with that equipment. This measure should target, but not be limited to, dehumidifiers put into service prior to June 2019. If provided data indicate the unit is replaced rather than retired, savings shall be based on the Residential Dehumidifier measure in this TRM.

Baseline Case

The baseline condition is the existing dehumidifier in working condition.

Efficient Case

The existing dehumidifier is removed from service and not replaced.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = capacity \times \frac{0.473}{24} \times hrs \times \frac{1}{L/kWh}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times RUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-54 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Capacity	Capacity of the unit	Site-specific. If unknown, use 56 pints/day	pints/day	
L/kWh	Dehumidifier Efficiency in liters (L) of water removed per kWh	Lookup in Table 2-55 based on manufacture date. If unknown, assume manufactuer date later than October 2012.[15]	L/kWh	[73][74][75]
0.473	Conversion factor	0.473	L/pint	
24	Conversion factor	24	Hr/day	
Hrs	Hours of use[16]	Site-specific. If unknown use 1,632	Hours/yr	[72]
CF	Electric coincidence factor	Lookup in Table 2-55	N/A	
PDF	Gas peak day factor	Lookup in Table 2-55	N/A	
RUL	Remaining useful life	See Measure Life Section	Years	[71]

Table 2-55 Dehumidifier Capacity and Efficiency

Capacity Range (pints/day)	ENERGY STAR Labeled (L/kWh)	Non-ENERGY STAR Labeled	
		Manufacture date before Oct. 2012 (≥L/kWh)	Manufacture date of Oct. 2012 or later (≥L/kWh)
≤ 25	1.57	1.00	1.35
>25 to ≤ 35	1.80	1.20	1.35

[15] Default manufacture date assumes that 2/3 of dehumidifier EUL (12 years) have elapsed [71]
(2/3) x (12 years) = 8 year vintage
2023 – (8 years) = 2015 manufacture date
[16] Default run hour assumption based on 68 days per year, 24 hours of use [72].

Capacity Range (pints/day)	ENERGY STAR Labeled (L/kWh)	Non-ENERGY STAR Labeled	
		Manufacture date before Oct. 2012 (≥L/kWh)	Manufacture date of Oct. 2012 or later (≥L/kWh)
>35 to ≤ 45	1.80	1.30	1.50
>45 to ≤ 50	1.80	1.30	1.60
>50 to ≤ 55	3.30	1.30	1.60
>54 to ≤ 75	3.30	1.50	1.70
>75 to ≤ 185	3.30	2.25	2.50

Peak Factors

Table 2-56 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.37[17]	[72]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) is 4 years [71].

References

[71] CA DEER gives the following rule-of-thumb for remaining useful life: RUL = (1/3) X EUL. As the Energy Star Dehumidifier [replacement] uses an EUL of 12 years, we have a suggested RUL of (1/3) X 12 years = 4 years.

[72] Savings Calculator for ENERGY STAR® Qualified Appliances Version 3.0 Last Updated October 1, 2012.

[73] ENERGY STAR® Program Requirements for Dehumidifiers, Version 5.0, February 2019.

[74] 42 U.S.C, Title 42 Chapter 77, Subchapter III, Part A, (cc)(1) and (cc)(2). https://uscode.house.gov/view.xhtml?path=/prelim@title42/chapter77/subchapter3&edition=prelim

[75] Code of Federal Regulations Title 10, Chapter 2, Subchapter D, Part 430, Subpart C (v)(1). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C

[17] Assume usage is evenly distributed day vs. night, weekend vs. weekday and is used between April through the end of September (4392 possible hours). 1632 operating hours from ENERGY STAR Dehumidifier Calculator. Coincidence peak during summer peak is therefore 1632/4392 = 37.2%, [72]

2.3 HVAC

2.3.1 CENTRAL AC, ASHP, MINI-SPLITS, PTAC, PTHP

Market	Residential/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure targets the use of central air conditioners, air source heat pumps, mini split heat pumps and ACs, packaged terminal systems (PTAC and PTHP) in residential and low-rise multifamily applications as further described below. This measure may apply to early replacement of an existing system, replacement on burnout, or installation of a new unit in a new or existing residential or multifamily low-rise building for HVAC applications.

The algorithms also include the calculation of additional energy and demand savings due to the proper sizing of high efficiency units.

Baseline Case

For whole building new construction, the baseline equipment is an instrustry standard equipment type for the facility compliant with IECC 2021 for single family and multifamily low-rise residential buildings (see Appendix E: Code-Compliant Efficiencies). For multifamily high-rise buildings, refer to commercial measure.

For replacement of failed equipment, or end of useful life, the baseline is a minimally code compliant version of the replaced system type and fuel.

For early replacement projects, use dual baselines:

- For the remaining useful life (RUL) of the existing equipment, the baseline is the actual existing equipment. If the site specific efficiency of the existing equipment is unknown, use the equipment efficiency from the IECC version in force when the equipment was new (if equipment vintage is unknown, use IECC 2012 efficiency requirements from Appendix E: Code-Compliant Efficiencies).
- For the duration of the measure life after the end of the RUL, the baseline is a code-compliant version of the replaced equipment.

Efficient Case

A central air conditioner, air source heat pump, mini split AC, mini split heat pump, or packaged terminal system (PTAC and PTHP) that exceeds code requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q + PSF \times kWh_{c,q}$$

Where,

$$kWh_b = OSF \times kWh_{c,b} + kWh_{h,b}$$

$$kWh_q = OSF \times kWh_{c,q} + kWh_{h,q}$$

Calculate $kWh_{c,b}$ and $kWh_{h,b}$ using the algorithms in Table 2-57 for the appropriate baseline equipment type.

Calculate $kWh_{c,q}$ and $kWh_{h,q}$ using the algorithms in Table 2-58 for the appropriate efficient equipment type.

Note:

- Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.
- The oversize derating factor (OSF) in the equations above is applicable for heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. The appropriate OSF should be determined from site-specific conditions if possible, otherwise use the default values provided below.

Table 2-57 Baseline Energy Consumption Equations

Baseline Equipment	Baseline Cooling kWh ($kWh_{c,b}$)	Baseline Heating kWh ($kWh_{h,b}$)
Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$
Mini-split AC, Air Conditioner (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	0
PTAC	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	0
PTHP	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$
Electric Resistance heating	0	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$
Room Air Conditioner	$\frac{Cap_c}{CEER_b \times 1{,}000} \times EFLH_c$	0

Table 2-58 Energy Efficient Energy Consumption Equations

Qualifying Equipment	Efficient Cooling kWh ($kWh_{c,q}$)	Efficient Heating kWh ($kWh_{h,q}$)
Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_q \times 1{,}000} \times EFLH_h$

Qualifying Equipment	Efficient Cooling kWh ($kWh_{c,q}$)	Efficient Heating kWh ($kWh_{h,q}$)
Mini-split AC, Central Air Conditioner (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_q \times 1{,}000} \times EFLH_c$	0
PTAC	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	0
PTHP	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_h$

Annual Fuel Savings

$$\Delta Therms = Therms_b - Therms_q$$

Where,

$$Therms_b = see \text{ Table 2-59 } for\ appropriate\ baseline\ equipment\ type$$

$$Therms_q = 0$$

Table 2-59 Baseline Fuel Consumption

Baseline Equipment	Baseline fuel consumption ($Therms_b$)
Gas Fired Furnace/Boiler	$\frac{Cap_h}{Eff_{b,fuel} \times 100{,}000} \times EFLH_h$
Electric resistance heating	0

Peak Demand Savings

$$\Delta kW_{Peak} = Cap_c \times \frac{1}{1{,}000} \times \left(\frac{1}{EER2_b} - \frac{1}{EER2_q}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-60 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_b	Baseline electrical consumption	Calculated	kWh/yr	
kWh_q	Energy efficient electrical consumption	Calculated	kWh/yr	
Cap_c	Cooling capacity of installed unit	Site-specific	Btu/hr	
Cap_h	Heating capacity of installed unit	Site-specific	Btu/hr	
$SEER2_q$	SEER2 of installed unit	Site-specific	Btu/W-h	
$IEER_q$	IEER of qualifying unit	Site-specific	Btu/W-h	
$EER2_q$	EER2 of qualifying unit	Site-specific	Btu/W-h	
COP_q	Coefficient of performance of the qualifying unit at 47F	Site-specific	N/A	
$HSPF2_q$	HSPF2 of the installed unit	Site-specific	Btu/W-h	
$SEER2_b$	SEER2 of baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[76][77][82][83]
$IEER_b$	IEER of baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[76][77][82][83]
EER_b	EER2 of baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[76][77][82][83]

Variable	Description	Value	Units	Ref
$HSPF2_b$	HSPF2 of the baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies. For electric resistance heat, use 3.412	Btu/W-h	[76][77][82][83]
$CEER_b$	Combined Energy Efficiency Ratio of baseline room air conditioner[18]	Use federal standard values in Appendix E: Code-Compliant Efficiencies, if unknown, use 11.0	Btu/W-h	[84]
$Eff_{b,fuel}$	Efficiency of baseline boiler/furnace	Site-specific or look up in Appendix E: Code-Compliant Efficiencies	N/A	[76][77][81]
OSF	Oversize derating factor[19]	Site-specific, if unknown Heat pumps: 0.8 Other applications: 1	N/A	
PSF	Proper sizing factor	Not properly sized or properly sized baseline equipment: 0 Properly sized: 0.05	N/A	[79]
$kWh_{c,b}$	Baseline cooling electrical consumption	Calculated from Table 2-57	kWh/yr	
$kWh_{h,b}$	Baseline heating electrical consumption	Calculated from Table 2-57	kWh/yr	
$kWh_{c,q}$	Energy efficient cooling electrical consumption	Calculated from Table 2-58	kWh/yr	
$kWh_{h,q}$	Energy efficient heating electrical consumption	Calculated from Table 2-58	kWh/yr	
$Therms_b$	Baseline fuel consumption	Calculated from Table 2-57	Therms/yr	
$Therms_q$	Energy efficient fuel consumption	0	Therms/yr	
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	

[18] Default value (11.0) is the CEER value from minimum Federal Standard for the most common room AC type – <8000 capacity range with louvered sides

[19] Heat pump systems may be sized to meet the peak heating load and will be oversized for cooling. The cooling EFLH assumes a nominal 20% oversizing. This derating factor has been added to account for the oversizing of heat pump cooling capacity when the unit is sized based on heating capacity. A user with a more accurate estimation of the oversizing can use a different factor than the one mentioned above to account for oversizing.

Variable	Description	Value	Units	Ref
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	
COP_b	Coefficient of performance of the baseline unit at 47F	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	N/A	[76][77][82][83]
1,000	Conversion from W to kW	1,000	W/kW	
3.412	Conversion factor from kWh to kBtu	3.412	kBtu/kWh	
CF	Cooling coincidence factor	Lookup in Table 2-61	N/A	[80]
PDF	Gas peak day factor	Lookup in Table 2-61	N/A	
EUL	Effective useful life	See Measure Life section	Years	[78]

Peak Factors

Table 2-61 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[80]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-62 Measure Life

Equipment	EUL	RUL	Ref
Central A/C	15	5	[78]
Air source heat pump	15	5	[78]
Mini split heat pump	15	5	[78]
PTAC/PTHP	15	5	[78]

References

[76] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[77] ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[78] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[79] *ENERGY STAR® HVAC QUALITY INSTALLATION PROGRAM A new approach to residential HVAC efficiency and performance*. Pg 2, https://www.energystar.gov/ia/home_improvement/downloads/ESQI_factsheet.pdf?07d7-31fc

[80] NEEP, *Mid-Atlantic Technical Reference Manual*, V9. (October 2019). Pg 95 https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf

[81] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430 eCFR. December 1, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[82] "2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES." n.d. Codes.iccsafe.org. Accessed November 16, 2022. https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency.

[83] "2012 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES." n.d. Codes.iccsafe.org. Accessed January 23, 2023 https://codes.iccsafe.org/content/IECC2012P5/chapter-4-ce-commercial-energy-efficiency

[84] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430, Subpart C, section 430.32 b) Room Air Conditioners

2.3.2 GROUND LOOP AND AIR-TO-WATER HEAT PUMP

Market	Residential/Multifamily
Baseline Condition	TOS/NC/EREP
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This prescriptive measure targets the use of ground loop and air-to-water heat pumps in residential and multifamily low-rise applications as further described below. This measure may apply to early replacement of an existing system, replacement on burnout, or installation of a new unit in a new or existing residential or low-rise residential building for HVAC applications.

Baseline Case

For whole building new construction and time of sale applications, the baseline equipment is an instrustry standard equipment type for the facility compliant with IECC 2021. For muli-family high-rise residential buildings, refer to the algorithms in Commercial and Industrial Section.

For replacement of failed equipment, or end of useful life, the baseline would be a minimally code compliant version of the replaced system type and fuel

For early replacement projects, use dual baselines:

- For the remaining useful life (RUL) of the existing equipment, the baseline is the actual existing equipment. In the lifetime algorithms section, annual savings for this period are designated as kWh_{ex} and $Therms_{ex}$. If the site specific efficiency of the existing equipment is unknown, use the equipment efficiency from the IECC version in force when the equipment was new (if equipment vintage is unknown, use IECC 2012).
- For the duration of the measure life after the end of the RUL, the baseline is a code-compliant version of the replaced equipment. In the lifetime algorithms section, annual savings for this period are designated as kWh_{TOS} and $Therms_{TOS}$.

Efficient Case

A ground loop and air-to-water heat pump that meets or exceeds code

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q + PSF \times kWh_{c,q}$$

Where,

$$kWh_b = OSF_b \times kWh_{c,b} + kWh_{h,b} + kWh_{p,b}$$

$$kWh_q = OSF_q \times kWh_{c,q} + kWh_{h,q} + kWh_{p,q}$$

Calculate $kWh_{c,b}$, $kWh_{h,b}$, and $kWh_{p,b}$ using the algorithms in Table 2-63 for the appropriate baseline equipment type.

Calculate $kWh_{c,q}$, $kWh_{h,q}$, and $kWh_{p,q}$ using the algorithms in Table 2-64 for the appropriate efficient equipment type.

Note:

- Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.
- The oversize derating factor (OSF) in the equations above is applicable for heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. The appropriate OSF should be determined from site-specific conditions if possible, otherwise use the default values provided below.

Table 2-63 Baseline Energy Consumption Equations

Baseline Equipment	Baseline Cooling kWh ($kWh_{c,b}$)	Baseline Heating kWh ($kWh_{h,b}$)	Baseline Circulating Pump kWh ($kWh_{p,b}$)
ASHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$	0
GSHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c \times EFLH_c}{GSER \times EER2_b \times 1{,}000}$	$\frac{Cap_h \times EFLH_h}{COP_b \times 3.412 \times 1{,}000}$	$\frac{0.746 \times HP_b \times LF}{Eff_{motor,b}} \times Hr$
GSHP (Cooling Capacity > 65 kBtu/h)	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_b \times LF}{Eff_{motor,b}} \times Hr$
DX A/C (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	0	0
DX A/C (Cooling Capacity > 65 kBtu/h)	$\frac{Cap_c}{IEER_b \times 1{,}000} \times EFLH_c$	0	0
Electric Resistance heating	0	$\frac{Cap_h}{3.412 \times 1{,}000} \times EFLH_h$	0

Table 2-64 Energy Efficient Energy Consumption Equations

Qualifying Equipment	Efficient Cooling kWh ($kWh_{c,q}$)	Efficient Heating kWh ($kWh_{h,q}$)	Efficient Circulating Pump kWh ($kWh_{p,q}$)
Water to air ground water heat pumps	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_q \times LF \times ESF_{VFD}}{Eff_{motor,q}} \times Hr$
Brine to air ground loop heat pump (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c \times EFLH_c}{GSER \times EER2_q \times 1{,}000}$	$\frac{Cap_{h,q} \times EFLH_h}{COP_q \times 3.412 \times 1{,}000}$	$\frac{0.746 \times HP_q \times LF \times ESF_{VFD}}{Eff_{motor,q}} \times Hr$

Qualifying Equipment	Efficient Cooling kWh ($kWh_{c,q}$)	Efficient Heating kWh ($kWh_{h,q}$)	Efficient Circulating Pump kWh ($kWh_{p,q}$)
Brine to air ground loop heat pump (Cooling Capacity > 65 kBtu/h)	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_q \times LF \times ESF_{VFD}}{Eff_{motor,q}} \times Hr$

Annual Fuel Savings

$$\Delta Therms = Therms_b - Therms_q$$

Where,

$$Therms_b = see \text{ Table 2-65 } for\ appropriate\ baseline\ equipment\ type$$

$$Therms_q = 0 \text{ (If the unit uses a furnace backup, use equation from Table 1-3)}$$

Table 2-65 Baseline Fuel Consumption

Baseline Equipment	Baseline fuel consumption ($Therms_b$)
ASHP, WSHP, GSHP	0
Gas Fired Furnace/Boiler	$\frac{Cap_h}{Eff_{b,fuel} \times 100{,}000} \times EFLH_h$
Electric resistance heating	0

Peak Demand Savings

$$\Delta kW_{peak,cool} = Cap_c \times \frac{1}{1{,}000}\left(\left(\frac{1}{EER2_b} \times \frac{1}{GSPK_b}\right) - \left(\frac{1}{EER2_q} \times \frac{1}{GSPK_q}\right)\right) \times CF_c$$

$$\Delta kW_{peak,pump} = 0.746 \times \left\{\left(HP_b \times LF \times \frac{1}{Eff_b}\right) - \left(HP_q \times LF \times \frac{1}{Eff_q} \times DSF_{VFD}\right)\right\} \times CF_{pump}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\, using\ existing\ baseline) \times RUL + (\Delta kWh\, using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-66 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_b	Baseline electrical consumption	Calculated	kWh/yr	
kWh_q	Energy efficient electrical consumption	Calculated	kWh/yr	
Cap_c	Cooling capacity of installed unit	Site-specific	Btu/hr	
Cap_h	Heating capacity of installed unit	Site-specific	Btu/hr	
$EER2_q$	EER of qualifying unit	Site-specific	Btu/W-h	
COP_q	Coefficient of performance of the qualifying unit	Site-specific	N/A	

Variable	Description	Value	Units	Ref
HP_q	Horsepower of qualifying ground/water loop circulating pump motor	Site-specific	HP	
HP_b	Horsepower of base case ground/water loop circulating pump motor	Site-specific, if unknown use HP_q	HP	
$SEER2_b$	SEER of baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[90][91][93][94]
$IEER_b$	IEER of baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[90][91][93][94]
EER_b	EER of baseline unit	Site-specific or lookup in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[90][91][93][94]
$HSPF2_b$	Heating seasonal performance factor of the baseline unit	Site-specific, if unkown lookup in Appendix E: Code-Compliant Efficiencies. For electric resistance heat, use 3.412	Btu/W-h	[90][91][93][94]
$Eff_{motor,b}$	Efficiency of base case ground/water loop circulating pump motor	Site-specific, if unknown lookup in Table 2-67	N/A	[92]
$Eff_{motor,q}$	Efficiency of qualifying ground/water loop circulating pump motor	Site-specific	N/A	[92]
$Eff_{b,fuel}$	Efficiency of baseline boiler/furnace	Site-specific or look up in Appendix E: Code-Compliant Efficiencies	N/A	[90][91]
PSF	Proper sizing factor	Not properly sized or properly sized baseline equipment: 0 Properly sized: 0.05	N/A	[96]
OSF_b	Baseline oversize derating factor	Site-specific, if unknown use 0.8	N/A	
OSF_q	Qualifying unit oversize derating factor	Site-specific, if unknown use 0.8	N/A	
$kWh_{c,b}$	Baseline cooling electrical consumption	Calculated from Table 2-63	kWh/yr	
$kWh_{h,b}$	Baseline heating electrical consumption	Calculated from Table 2-63	kWh/yr	
$kWh_{p,b}$	Baseline pump electrical consumption	Calculated from Table 2-63	kWh/yr	
$kWh_{c,q}$	Energy efficient cooling electrical consumption	Calculated from Table 2-64	kWh/yr	
$kWh_{h,q}$	Energy efficient heating electrical consumption	Calculated from Table 2-64	kWh/yr	

Variable	Description	Value	Units	Ref
$kWh_{p,q}$	Energy efficient pump electrical consumption	Calculated from Table 2-64	kWh/yr	
$Therms_b$	Baseline fuel consumption	Lookup in Table 2-65	Therms/yr	
$Therms_q$	Energy efficient fuel consumption	0	Therms/yr	
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	
COP_b	Coefficient of performance of the baseline unit	Lookup in Appendix E: Code-Compliant Efficiencies	N/A	[90][91][93][94]
GSER	Factor used to determine the seasonal efficiency of a GSHP based on its EER	1.02	N/A	[85]
$GSPK_b$	Factor to convert EER of GSHP to the equivalent EER of an air conditioner	Non GSHP Baseline:1 GSHP:0.8416	N/A	[86]
$GSPK_q$	Factor to convert EER of GSHP to the equivalent EER of an air conditioner	0.8416	N/A	[86]
1,000	Conversion from W to kW	1,000	W/kW	
3.412	Conversion factor from kWh to kBtu	3.412	kBtu/kWh	
0.746	Conversion from HP to kW	0.746	kW/hp	
LF	Load factor of pump motor	0.75	N/A	[87]
ESF_{VFD}	Energy savings factor to account for variable speed pumping in qualifying unit	If variable speed pump: 0.661 If constant speed: 1.0		[98]
DSF_{VFD}	Demand savings factor to account for variable speed pumping in qualifying unit	If variable speed pump: 0.210 If constant speed: 1.0		[98]
Hrs	Operating hours of pump motor	Site-specific, if unknown use $EFLH_c$+$EFLH_h$	Hours	
CF_c	Cooling coincidence factor	Lookup in Table 2-68	N/A	
CF_{pump}	Pump coincidence factor	Lookup in Table 2-68	N/A	
PDF	Gas peak day factor	Lookup in Table 2-68	N/A	
EUL	Effective useful life	See	Years	

Variable	Description	Value	Units	Ref
		Measure Lifesection		
RUL	Remaining useful life	See Measure Life section	Years	

Table 2-67 Federal Baseline Motor Efficiencies

Motor HP	Motor Nominal Full-Load Efficiencies (percent)							
	2 Poles		4 Poles		6 Poles		8 Poles	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0

Peak Factors

Table 2-68 Peak Factors

Peak Factor	Value	Ref
Cooling coincidence factor (CFc)	0.69	[95]
Pump coincidence factor (CF_{pump})	If unit runs 24/7/365, CF=1.0, else use 0.5	[97]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-69 Measure Life

Equipment	EUL	RUL	Ref
Water source Pump	15	5	[89]
Ground source heat pump	25	8.33	[88]

References

[85] VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.

[86] VEIC estimate. Extrapolation of manufacturer data.

[87] *Determining Electric Motor Load and Efficiency*. (DOE, 2014), pg 1, https://www.energy.gov/sites/prod/files/2014/04/f15/10097517.pdf

[88] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1

[89] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[90] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[91] ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[92] *§ CFR431.25 Energy conservation standards and effective dates*, (2023) Table 1, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-B/subject-group-ECFR03b7039d87b7cc6/section-431.25

[93] “2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES.” n.d. Codes.iccsafe.org. Accessed November 16, 2022. https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency.

[94] “2012 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES.” n.d. Codes.iccsafe.org. Accessed January 23, 2023 https://codes.iccsafe.org/content/IECC2012P5/chapter-4-ce-commercial-energy-efficiency

[95] NEEP, *Mid-Atlantic Technical Reference Manual*, V9. (October 2019). Pg 95

[96] ENERGY STAR® HVAC QUALITY INSTALLATION PROGRAM A new approach to residential HVAC efficiency and performance. Pg 2, https://www.energystar.gov/ia/home_improvement/downloads/ESQI_factsheet.pdf?07d7-31fc

[97] Determining Electric Motor Load and Efficiency. (DOE, 2014), pg 1, https://www.energy.gov/sites/prod/files/2014/04/f15/10097517.pdf

[98] See section 3.8.2 VFD

2.3.3 GAS FORCED AIR AND HYDRONIC HEAT

Market	Residential/Multifamily
Baseline Condition	TOS/NC/EREP
Baseline	Code/Existing
End Use Subcategory	HVAC Equipment
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for qualifying furnaces and boilers installed in single family detached and lowrise multifamily buildings. The input values are based on the specifications of the actual equipment being installed and IECC 2021 standards which require an efficiency rating equal to or greater than the minimum required by federal law for single family units and an efficiency rating efficiency rating equal to or greater than the minimum required by ASHRAE 90.1 2019 for systems serving multi family units.

In the case of new construction, replacement of failed equipment, or end of useful life,the baseline furnace or boiler is a minimally code compliant unit with an efficiency as required by IECC 2021, which is the current residential code adopted by the state of New Jersey.

In the case of early replacement of a working unit where the unit would have otherwise continued to function, the dual baseline approach must be followed. Otherwise the savings can be calculated as a time of sale (TOS) measure.

Baseline Case

New construction, time of sale:

- Single Family and Low-Rise Multifamily – Equipment compliant with the IECC 2021 [99].

Early Replacement:

- Existing equipment - Efficiency of the existing equipment for the assumed over remaining useful life of the existing unit, and the Time of Sale (TOS) baseline for the remainder of the new, efficient equipment measure life. If existing equipment efficiency is unknown, use the code in force when equipment was new.

Efficient Case

Furnace or boiler with an efficiency higher than code or standard practice.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = Cap_{in} \times EFLH_h \times \frac{Eff_q/Eff_b - 1}{100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-70 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
Cap_{in}	Input capacity of qualifying unit	Site-specific	kBtu/hr	
Eff_q	Furnace or Boiler Proposed Efficiency	Site-specific	N/A	

Variable	Description	Value	Units	Ref
Eff_b	Furnace or Boiler Baseline Efficiency	Site-specific or unknown lookup in Table 2-71 – single family detached/multifamily low-rise Table 2-73 – Multifamily Units	N/A	[99]
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Lookup in Appendix C: Heating and Cooling EFLH	Hrs/yr	
100	Conversion factor	100	kBtu/Therms	
EUL	Estimated useful life	See Measure Life section	years	[100]
RUL	Remaining useful life	See Measure Life section	years	[100]
PDF	Gas peak day factor	Lookup in Table 2-74	N/A	

Table 2-71 Baseline AFUE of Single Family and Low-Rise Multifamily Furnaces

Product Class	AFUE	Compliance Date	AFUE (Manufactured before compliance Date)
Weatherized gas furnaces	81	January 1, 2015.	78
Non-weatherized gas furnaces (not including mobile home furnaces)	80	November 19, 2015.	78
Weatherized oil-fired furnaces	78	January 1, 1992.	78
Non-weatherized oil-fired furnaces (not including mobile home furnaces)	83	May 1, 2013.	78
Mobile Home gas furnaces	80	November 19, 2015.	75
Mobile Home oil-fired furnaces	75	September 1, 1990.	75

* Electric resistance heating calculated by determining overall fuel cycle efficiency by dividing the average PJM heat rate (9,642 btu/kWh) by the btu's per kWh (3,413 btu/kWh), resulting in 2.38 btu_{in} per 1 btu_{out}.

Table 2-72 Baseline AFUE of Single Family and Low-Rise Multifamily Boilers

Product Class	AFUE Manufactured before Sep 1, 2012	AFUE (Manufactured on and after Sep 1, 2012 and before Jan 15, 2021)	AFUE (Manufactured on and after January 15, 2021)
Gas-fired hot water boiler	0.80	0.82	0.84
Gas-fired steam boiler	0.75	0.80	0.82
Oil-fired hot water boiler	0.80	0.84	0.86
Oil-fired steam boiler	0.80	0.82	0.85

Table 2-73 Baseline Efficiencies for Multifamily Units

Product Class	Minimum Efficiency for Units Before 1/1/2023	Minimum Efficiency for Units After 1/1/2023
Warm-air furnace, gas fired	80% E_t	81% E_t
Warm-air furnace, oil fired	80% E_t	82% E_t
Warm-air duct furnaces, gas fired	80% E_c	80% E_c

Peak Factors

Table 2-74 Peak Factors

Peak Factor	Value	Ref
Natural gas peak day factor (PDF)	Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for retrofit projects is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-75 Measure Life

Equipment	New construction EUL	Retrofit RUL	Ref
Furnace	20	6.7	[100]
Boiler	20	6.7	[5]

References

[99] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430, Subpart C §430.32(e). December 1, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32#p-430.32(e)

[100] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[101] U.S. DOE. “Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces” and “Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces.” August 30, 2016. Available from: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0217

2.3.4 HIGH EFFICIENCY BATHROOM EXHAUST FAN

Market	Residential/Multifamily
Baseline Condition	TOS/DI/EREP
Baseline	Existing
End Use	Ventilation Fan
Measure Last Reviewed	December 2022

Description

This market opportunity is defined by the need for continuous mechanical ventilation due to reduced air-infiltration from a tighter building shell. In retrofit projects, existing fans may be too loud, or insufficient in other ways, to be operated as required for proper ventilation.This measure assumes a fan capacity of 20 CFM at 0.1 inches of water column (w.c.) static pressure and a decibel level below 2 sones. Installations should be sized to meet the minimum ventilation rate as required by ASHRAE 62.2.

Baseline Case

Standard efficiency quiet bathroom ventilation fan, operating at a ventilation rate compliant with ASHRAE 62.2, with an average efficiency of 3.1 CFM/watt

Efficient Case

Energy efficient quiet bathroom ventilation fan, operating at a ventilation rate compliant with ASHRAE 62.2, with an average efficiency of 8.3 CFM/watt

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = CFM \times \left(\frac{1}{Eff_b} - \frac{1}{Eff_q}\right) / 1{,}000 \times Hrs$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = CFM \times \left(\frac{1}{Eff_b} - \frac{1}{Eff_q}\right) / 1{,}000 \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-76 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
CFM	Nominal Capacity of the exhaust fan	Site-specific, if unknown use 20 CFM	CFM	[102]
Eff_b	Average efficacy for baseline fan	Site-specific, if unknown use 3.1 CFM/watt	CFM/watt	[103]
Eff_q	Average efficacy for efficient fan	Site-specific, if unknown use 8.3 CFM/watt	CFM/watt	[104]
Hrs	Annual hours of operation	8,760	Hrs/yr	
CF	Electric coincidence factor	Lookup in Table 3-133	N/A	
EUL	Effective useful life	See Measure Life section	Years	

Peak Factors

Table 2-77 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	

Measure Life

The effective useful life (EUL) is 19 years [105].

References

[102] 20 CFM is used with continuous bathroom ventilation in ASHRAE 62.2. Note that 50CFM is the closest available fan size to ASHRAE 62.2 Section 4.1 Whole House Ventilation rates based upon typical square footage and bedrooms

[103] VEIC analysis looking at average baseline fan (i.e. non-Brushless Permanent Magnet) efficacies at static pressures of 0.1 and 0.25 inches of water column for quiet fans rated for 50 CFM

[104] VEIC analysis looking at average efficient fan (i.e. Brushless Permanent Magnet) efficacies at static pressures of 0.1 and 0.25 inches of water column for quiet fans rated for 50 CFM

[105] GDS Associates, *Measure Life Report: Residential and C&I Lighting and HVAC measures* (SPWG 2007), https://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf

2.3.5 EC MOTOR

Market	Residential/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Motor
Measure Last Reviewed	December 2022

Description

This measure covers the retrofit installation of an Electronically Commuted (EC) Motor to replace an HVAC supply fan motor or hydronic circulator pump motor in residential heating and cooling systems.

The deemed annual electric energy savings for fans are determined for each New Jersey location by scaling the energy savings derived from the evaluation of a 2014 Wisconsin ECM metering study using heating degree days and cooling degree days for each location.

Electric energy savings for pumps are calculated by multiplying the difference in the reciprocal of motor efficiencies with the efficient circulator motor horsepower.

Baseline Case

An existing HVAC fan or pump with a single-speed, shaded-pole (SP) or permanent-split capacitor (PSC) motor.

Efficient Case

HVAC fan or pump with an Electronically Commuted (EC) Motor.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Pumps:

$$\Delta kWh = \Delta kWh_h + \Delta kWh_c$$

Where,

$$\Delta kWh_h = hp \times \left(\frac{1}{Eff_b} - \frac{1}{Eff_q}\right) \times LF \times 0.746 \times hrs_h$$

$$\Delta kWh_c = hp \times \left(\frac{1}{Eff_b} - \frac{1}{Eff_q}\right) \times LF \times 0.746 \times hrs_c$$

Fans:

$$\Delta kWh = \Delta kWh_{fan}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

Pumps:

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF_{pump}$$

Fans:

$$\Delta kW_{Peak} = \Delta kW_{fan} \times CF_{fan}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL = N/A$$

Calculation Parameters

Table 2-78 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Annual peak electric demand savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{fan}	Annual energy savings per fan motor	Look up in Table 2-80	kWh/unit	[106] [107]
ΔkW_{fan}	Electric demand savings per fan motor	Central A/C: 0.116 No Central A/C: 0	kW/unit	[107]

Variable	Description	Value	Units	Ref
		Unknown: 0.05[20]		
hp	Efficient circulator motor horsepower	Site-specific	HP	
Eff_b	Baseline motor efficiency	Site-specific, if unknown look up in Table 2-79	N/A	[109]
Eff_q	Efficient motor efficiency	Site-specific, if unknown look up in Table 2-79	N/A	[109]
LF	Motor load Factor	0.9	N/A	[108] [110]
hrs_h	Operating hours during the heating season	3,504	hrs/yr	[110]
hrs_c	Operating hours during the cooling season[21]	2,208	hrs/yr	[110]
hrs	Total operating hours	5,712	hrs/yr	
0.746	Conversion factor for HP to kWh	0.746	kW/HP	
CF_{fan}	Electric coincidence factor fan	Look up in Table 2-81	N/A	
CF_{pump}	Electric coincidence factor pump	Look up in Table 2-81	N/A	
EUL	Effective Useful Life	See Measure Life Section	Years	
RUL	Remaining Useful Life	See Measure Life Section	Years	

Table 2-79 Default Motor Efficiency by Motor Type

Motor Type	Assumed Efficiency
Shaded Pole (SP)	0.40
Permanent Split Capacitor (PSC)	0.50
ECM	0.70

Table 2-80 Annual Fan Energy Savings

Climate Region	Annual Energy Saved (ΔkWh_{fan})					HDD	CDD
	Total with Central AC	Total without Central AC	Circulation Mode	Heating Mode	Cooling Mode		
North	408	315	211	104	93	5,734	778

[20] Weighted average calculated using RECS 2020 Data -https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%207.7.pdf
[21] Cooling assumes three months (92 days) of 24 hour operation

Climate Region	Annual Energy Saved (ΔkWh_{fan})					HDD	CDD
	Total with Central AC	Total without Central AC	Circulation Mode	Heating Mode	Cooling Mode		
Coastal	422	295	211	84	127	4,614	1056
Central	432	303	211	92	129	5,052	1073
Pine barrens	428	300	211	89	128	4,891	1067
Southwest	428	303	211	92	125	5,029	1047
Statewide Average	425	303	211	92	122	5,078	1,017

*The percent difference in HDD is applied to the Heating Mode column kWh savings and the percent difference in the CDD is applied to the Cooling Mode column kWh savings.

Peak Factors

Table 2-81 Peak Factors

Peak Factor	Value	Ref
Fan coincidence factor (CF_{fan})	0.68	[107]
Pump coincidence factor (CF_{pump})	0.8	[111]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for retrofit projects is limited to the RUL of the host equipment. If unknown, assume 1/3 of the host equipment EUL.

References

[106] ONJSC: Monthly/Annual Temperature Normals (1991-2020). http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html

[107] Annual energy savings per fan motor were calculated for each New Jersey location by scaling the energy savings derived from the evaluation of a 2014 Wisconsin ECM metering study using heating degree days and cooling degree days for each location. Cadmus Group. *Focus on Energy Evaluated Deemed Savings Changes*. November 2014.

[108] US DOE, *Evaluation of Retrofit Variable-Speed Furnace Fan Motors*, January 2014. https://www.nrel.gov/docs/fy14osti/60760.pdf

[109] DOE Building Technologies Office. Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment. https://www.energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf. Accessed December 2022

[110] M Samotyj, *Assessment of New Energy Efficient Circulator Pump Technology*. (EPRI, 2010), Pg 4-3, https://www.epri.com/research/products/1020132

[111] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs V9*. (New York State Joint Utilities, 2021), Pg 211, technitechnical-resource-manual-version-9-filed-october-27-2021-effective-january-1-2022.pdf (ny.gov)cal-resource-manual-version-9-filed-october-27-2021-effective-january-1-2022.pdf (ny.gov)

2.3.6 DUCT SEALING AND DUCT INSULATION

Market	Residential/Multifamily
Baseline Condition	RF/DI
Baseline	Existing
End Use Category	HVAC
Measure Last Reviewed	January 2023

Description

This measure describes evaluating the savings associated with performing duct sealing using mastic sealant or metal tape to the distribution system of homes with either central air conditioning or a ducted heating system. The measure also applies to insulating ductwork in unconditioned and semi-conditioned spaces of residential buildings.

If duct insulation is involved with the improvement, the first method, "Evaluation of Distribution Efficiency," must be used to estimate energy savings.

1) Evaluation of Distribution Efficiency – this methodology requires the evaluation of three duct characteristics below, and use of the Building Performance Institute's (BPI) "Guidance on Estimating Distribution Efficiency" [112], which are summarized in

Table 2-83 and Table 2-84 for convenience.

- Duct location, including percentage of duct work found within the conditioned space
- Duct leakage evaluation. The duct leakage assessment values are based on an assumption of 6.5% of assumed air handler flow (tight); 21% (average); or 35% (leaky).
- Duct insulation evaluation

Determine Distribution Efficiency by evaluating duct system before and after duct sealing using Building Performance Institute "Guidance on Estimating Distribution Efficiency" or the values reproduced from that document in Table 2-84 that match the duct system, and if the majority of the duct system is in conditioned space add the matching value fromTable 2-85, not to exceed 100%.

2) RESNET Test 380 4.4.2 – this method involves the pressurization of the house to 25 Pascals with reference to outside and a simultaneous pressurization of the duct system to reach equilibrium with the envelope or inside pressure of zero Pascals. A blower door is used to pressurize the building to 25 Pascals with reference to outside, when that is achieved the duct blaster is used to equalize the pressure difference between the duct system and the house. The amount of air required to bring the duct system to zero Pascals with reference to the building is the amount of air leaking through the ductwork to the outside. This technique is described in detail in section 4.4.2 of the ANSI/RESNET/ICC 380 - 2016 Standards: http://www.resnet.us/professional/standards

Baseline Case

The baseline condition is existing leaky duct work within the unconditioned space in the home.

Efficient Case

The efficient condition is sealed duct work throughout the unconditioned space in the home.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Methodology 1: Evaluation of distribution efficiency

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

Where,

$$\Delta kWh_{cooling} = \frac{DE_{post,cool} - DE_{pre,cool}}{DE_{post,cool}} \times EFLH_{cool} \times \frac{Cap_{cool}}{SEER}$$

$$\Delta kWh_{heating} = \frac{DE_{post,heat} - DE_{pre,heat}}{DE_{post,heat}} \times EFLH_{heat} \times \frac{Cap_{heat}}{HSPF}$$

Methodology 2: RESNET Test 803.7

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

Where,

$$\Delta kWh_{cooling} = \frac{CFM_{25B} - CFM_{25Q}}{400} \times EFLH_{cool} \times \frac{12}{SEER}$$

$$\Delta kWh_{heating} = \frac{CFM_{25B} - CFM_{25Q}}{400} \times EFLH_{heat} \times \frac{12}{HSPF}$$

Annual Fuel Savings

$$\Delta Therms = \frac{\frac{DE_{post,heat} - DE_{pre,heat}}{DE_{post,heat}} \times EFLH_{heat} \times Cap_{heat}}{AFUE \times 100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh_{cooling}}{EFLH_{cool}} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-82 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{cooling}$	Annual electric energy savings, cooling	Calculated	kWh/yr	
$\Delta kWh_{heating}$	Annual electric energy savings, heating	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
Cap_{cool}	Capacity of air cooling system	Site-specific	kBtu/hr	
Cap_{heat}	Capacity of air heating system	Site-specific	kBtu/hr	
CFM_{25B}	Standard duct leakage test result at 25 Pascal pressure differential of the duct system prior to sealing	Site-specific	CFM	
CFM_{25Q}	Standard duct leakage test result at 25 Pascal pressure differential of the duct system after sealing	Site-specific	CFM	
SEER	Seasonal energy efficiency ratio	Site-specific, if unknown look up in Table 2-85	Btu/W·hr	[112]
HSPF	Heating seasonal performance factor	Site-specific, if unknown look up in Table 2-85	Btu/W·hr	[112]
DE_{post}	Distribution efficiency after duct sealing and insulation	Look up in Table 2-83. For conditioned area, look up adder in Table 2-84	N/A	[113]
DE_{pre}	Distribution efficiency before duct sealing and insulation	Look up in Table 2-83. For conditioned area, look up adder in Table 2-84	N/A	[113]
AFUE	Annual fuel utilization efficiency	Look up in Table 2-86	N/A	[112]
$EFLH_{cool}$	Cooling equivalent full load hours	Lookup in Appendix C: Heating and Cooling EFLH	Hrs	
$EFLH_{heat}$	Heating equivalent full load hours	Lookup in Appendix C: Heating and Cooling EFLH	Hrs	

Variable	Description	Value	Units	Ref
400	Rule of Thumb, CFM/ton	Site-specific, if unknown use 400	CFM/ton	
12	Unit conversion, kBtu/hr·ton	12	kBtu/ hr·ton	
100	Unit conversion, kBtu/therm	100	kBtu/therm	
CF	Electric coincidence factor	Look up in Table 2-87	N/A	
PDF	Gas peak day factor	Look up in Table 2-87	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-83 Distribution Efficiencies

Duct Insulation	Location	Attic		Basement		Vented Crawl	
	Leakage Assessment / HVAC Type	Heat	Cool	Heat	Cool	Heat	Cool
R-0	Leaky	0.69	0.61	0.93	0.81	0.74	0.76
	Average	0.73	0.64	0.94	0.87	0.78	0.83
	Tight	0.77	0.73	0.95	0.94	0.82	0.91
R-2	Leaky	0.76	0.65	0.94	0.83	0.80	0.78
	Average	0.82	0.74	0.96	0.88	0.85	0.85
	Tight	0.87	0.84	0.97	0.95	0.90	0.93
R-4+	Leaky	0.79	0.67	0.95	0.83	0.82	0.79
	Average	0.84	0.77	0.96	0.89	0.87	0.86
	Tight	0.90	0.87	0.98	0.95	0.92	0.94
R-8+	Leaky	0.80	0.69	0.95	0.83	0.84	0.79
	Average	0.86	0.79	0.97	0.89	0.89	0.87
	Tight	0.92	0.90	0.98	0.95	0.94	0.94

For duct systems partly in unconditioned and conditioned space, add the values from Table 2-84 below to DE_{pre} and DE_{post} determined from

Table 2-83, with a max DE of 100%. Use the 50% adder values if 50% or more of the duct system is inside a conditioned space. Use the 80% adder values if 80% of more of the duct system is inside a conditioned space.

Table 2-84 Distribution Efficiencies Adders for Conditioned Space

Location	Attic				Basement				Vented Crawl			
HVAC Type	Heat		Cool		Heat		Cool		Heat		Cool	
Insulation/ Conditioned	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%	50%	80%
R-0	0.06	0.11	0.04	0.09	0.02	0.03	0.02	0.03	0.06	0.11	0.03	0.05
R-2	0.04	0.06	0.04	0.07	0.01	0.01	0.01	0.02	0.03	0.05	0.02	0.03
R-4+	0.03	0.04	0.03	0.05	0.01	0.01	0.01	0.01	0.02	0.04	0.01	0.03
R-8+	0.02	0.03	0.02	0.03	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02

Table 2-85 SEER and HSPF Values

Product Class	SEER	HSPF
Split systems – air conditioners	13	-
Split systems – heat pumps	14	8.2
Single package units – air conditioners	14	-
Single package units – heat pumps	14	8.0

Table 2-86 AFUE Values

Product Class	AFUE
Gas-fired hot water boiler	0.82
Gas-fired steam boiler	0.80
Oil-fired hot water boiler	0.84
Oil-fired steam boiler	0.82
Non-weatherized gas furnaces	0.80
Mobile home gas furnaces	0.80
Non-weatherized oil-fired furnaces	0.83
Mobile home oil-fired furnaces	0.75
Weatherized gas furnaces	0.81
Weatherized oil-fired furnaces	0.78
Electric furnaces	0.78

Peak Factors

Table 2-87 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[114]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-88 Measure Life

Equipment	EUL	RUL	Ref
Duct Sealing & Duct Insulation	15	5	[116]

References

[112] 10 CFR Subpart C of Part 430, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[113] Building Performance Institute, Duct Efficiency Tables, http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf

[114] BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.

[115] Residential Energy Services Network, ANSI/RESNET/ICC 380-2019. http://www.resnet.us/blog/wp-content/uploads/2016/01/ANSI-RESNET-ICC_380-2016-posted-on-website-6-15-16.pdf

[116] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

2.3.7 HEAT OR ENERGY RECOVERY VENTILATOR

Market	Residential/Multifamily
Baseline Condition	NC/TOS
Baseline	Code
End Use Subcategory	Heat Recovery
Measure Last Reviewed	December 2022

Description

This measure covers the installation of Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV). ERVs and HRVs reduce heating and cooling loads while maintaining required ventilation rates by facilitating heat transfer between outgoing conditioned air and incoming outdoor air. ERVs and HRVs employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of pre-conditioning outdoor air prior to supplying the conditioned air to the space, either directly or as part of an air-conditioning system. This measure only applies in cases where ERV/HRV functionality is not required by federal, state, local, or municipal codes or standards. For the purposes of this measure, ERVs and HRVs are distinguished as follows:

- Energy Recovery Ventilator (ERV): Transfers both sensible (heat content) and latent (moisture content) heat between supply and exhaust airstreams.
- Heat Recovery Ventilator (HRV): Transfers sensible heat only between supply and exhaust airstreams.

Baseline Case

The baseline condition for this measure is a single- or multifamily dwelling with an IECC 2021-compliant exhaust fan system with no heat or energy recovery.

Efficient Case

The compliance condition for this measure is a single- or multifamily dwelling with an ASHRAE 62.2-compliant exhaust fan system equipped with AHRI certified ERV or HRV components.

Annual Energy Savings Algorithm

Note: Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_c + \Delta kWh_h + \Delta kWh_{fan}$$

Cooling energy savings:

For ERVs:

$$\Delta kWh_c = \frac{4.5 \times CFM \times Eff_{hx,total} \times \left(H_{outdoor,c} - H_{indoor}\right)}{1{,}000 \times SEER2} \times hrs_c$$

For HRVs:

$$\Delta kWh_c = \frac{1.08 \times CFM \times Eff_{hx,sens} \times \left(T_{outdoor,c} - T_{indoor}\right)}{1{,}000 \times SEER2} \times hrs_c$$

Heating energy savings (both ERVs and HRVs):

$$\Delta kWh_h = \frac{1.08 \times CFM \times Eff_{hx,sens} \times \left(T_{indoor} - T_{outdoor,h}\right)}{1{,}000 \times HSPF2} \times F_{ElecHeat} \times hrs_h$$

Fan energy savings:

$$\Delta kWh_{fan} = \Delta kW_{fan} \times (hrs_h + hrs_c)$$

$$\Delta kW_{fan} = CFM \times 1{,}000 \times \left(\frac{1}{(cfm/watt)_b} - \frac{1}{(cfm/watt)_q}\right)$$

Annual Fuel Savings

$$\Delta Therms = \frac{1.08 \times CFM \times Eff_{hx,sens} \times \left(T_{indoor,h} - T_{oudoor,h}\right)}{100{,}000 \times AFUE} \times F_{FuelHeat} \times hrs_h$$

Summer Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{1.08 \times CFM \times Eff_{hx,sense} \times (T_{outdoor,c,peak} - T_{indoor,c})}{1{,}000 \times EER} + \Delta kW_{fan}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-89 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔkWh_c	Annual electric energy savings during cooling season	Calculated	kWh	
ΔkWh_h	Annual electric energy savings during heating season	Calculated	kWh	
ΔkWh_{fan}	Annual electric energy savings due to fan operation	Calculated	kWh	
CFM	Flow rate of supply air passing through ERV/HRV	Site-specific	Ft^3/min	
$(cfm/watt)_b$	Baseline ERV/HRV fan efficacy	Look up in Table 2-93	cfm/watt	[123]
$(cfm/watt)_q$	Efficient ERV/HRV fan efficacy	Site-specific	cfm/watt	
$Eff_{hx,total}$	Total effectiveness of heat exchanger per rating in accordance with AHRI Standard 1060	Site-specific	N/A	[117]
Effhx,sens	Sensible effectiveness of heat exchanger per rating in accordance with AHRI Standard	Site-specific, if unknown use 0.65	N/A	[123]
SEER2	Seasonal average energy efficiency of electric cooling equipment	Site-specific, if unknown lookup in Appendix E: Code-Compliant Efficiencies for equipment type and size	Btu/watt-hour	
EER2	Energy efficiency ratio of electric cooling equipment[22]	Site-specific, if unknown lookup in Appendix E: Code-Compliant Efficiencies for equipment type and size	Btu/watt-hour	
HSPF2	Heating seasonal performance factor of electric heating equipment[23]	Site-specific, if unknown lookup in Appendix E: Code-Compliant Efficiencies for equipment type and size	Btu/watt-hour	

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[22] If needed, calculate EER as follows:
$EER = (1.12 \times SEER) - (0.02 \times SEER^2)$
[23] If needed, convert COP to HSPF as follows:
$HSPF = COP \times 3.412$. COP for electric resistance heat is 1.0

Variable	Description	Value	Units	Ref
AFUE	Efficiency of fossil fuel heating equipment (AFUE, Et or Ec)	Site-specific, if unknown lookup in Appendix E: Code-Compliant Efficiencies for equipment type and size	N/A	
$T_{indoor,h}$	Indoor heating setpoint temperature	Site-specific, if unknown use 70	°F	
$T_{indoor,c}$	Indoor cooling setpoint temperature	Site-specific, if unknown use 70	°F	
H_{indoor}	Enthalphy of indoor air	Lookup in Table 2-90 based on T_{indoor}	Btu/lb	
HP	Total fan horsepower	Site-specific	HP	
LF	Load factor	Site-specific, if unknown use 0.92	N/A	[122]
hrs_c	Operating hours in the cooling season	Look up in Table 2-90	hrs	[120]
hrs_h	Operating hours in the heating season	Look up in Table 2-90	hrs	[120]
$T_{outdoor,c}$	Temperature of outside air during cooling	Look up in Table 2-91	Btu/lb	[121]
$T_{outdoor,h}$	Temperature of outside air during heating	Look up in Table 2-91	Btu/lb	[121]
$T_{outdoor,c,peak}$	Peak outdoor temperature during cooling season	Look up in Table 2-94	°F	[124]
$H_{outdoor,c,peak}$	Peak Enthalpy of outdoor air during cooling season	Look up in Table 2-94	°F	[124]
$H_{outdoor,c}$	Enthalpy of outside air during cooling	Lookup in Table 2-91	Btu/lb	[121]
$F_{ElecHeat}$	Electric heating factor, to account for presence of electric heat	Use 1 if electric heat, otherwise use 0	N/A	
$F_{FuelHeat}$	Fuel heating factor, to account for presence of fuel heat	Use 1 if fuel heat, otherwise use 0	N/A	
1.08	Specific heat of air × density of inlet air @ 70°F × 60 min/hr	1.08	BTU/h.°F.CFM	
4.5	Density of inlet air at 70 °F x 60 min/hr	4.5	Lb.min/ft^3.hr	
60	Minutes per hour	60	Min/hr	
1,000	Conversion factor, one kW equals 1,000 Watts	1,000	W/kW	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
0.746	Conversion from horsepower to kW	0.746	kW/hp	
CF	Electric coincidence factor	Look up in Table 2-95	N/A	[118]
PDF	Gas peak day factor	Look up in Table 2-95	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-90 Indoor Enthalpy

Temperature, T_{indoor} (°F)	Enthalpy, H_{indoor} at 50% Relative Humidity (Btu/lb)	Temperature, T_{indoor} (°F)	Enthalpy, H_{indoor} at 50% Relative Humidity (Btu/lb)
65	22.7	72	26.4
66	23.2	73	27.0
67	23.7	74	27.5
68	24.2	75	28.1
69	24.8	76	28.7
70	25.3	77	29.3
71	25.8	78	29.9

Table 2-91 Heating and Cooling Hours[24]

NJ Climate Region	Heating Hours, hrs_h	Cooling Hours, hrs_c
Northern	4,970	1,670
Southwest	4,896	1,783
Coastal	4,981	1,954
Central	4,969	1,810
Pine Barrens	4,899	1,828
Statewide Average	4,955	1,808

Table 2-92 Outdoor Air Temperature and Enthalpy

NJ Climate Region	Avg. outdoor temperature during cooling season, $T_{outdoor,c}$ (°F)	Avg. outdoor temperature during heating season, $T_{outdoor,h}$ (°F)	Avg. enthalpy[25] of outdoor air at duing cooling season, $H_{outdoor,c}$ (Btu/lb)
Northern	74.6	42.1	13.1
Southwest	74.5	42.7	27.8
Coastal	73.0	46.2	27.0
Central	74.3	43.2	27.7
Pine Barrens	73.7	43.4	27.4

[24] Calculated from TMY3 data for representative weather stations for each NJ climate zone. Cooling hours are defined as any hour when outdoor air temperature is above 65°F for the months of June through August and heating hours are defined as any hour when outdoor air temperature is below 65°F for the months of October through April. The heating and cooling hours above represent the count of each in a typical meteorological year.

[25] Assuming 50% relative humidity

NJ Climate Region	Avg. outdoor temperature during cooling season, $T_{outdoor,c}$ (°F)	Avg. outdoor temperature during heating season, $T_{outdoor,h}$ (°F)	Avg. enthalpy[25] of outdoor air at duing cooling season, $H_{outdoor,c}$ (Btu/lb)
Statewide Average	74.1	43.5	25.1

Table 2-93 Baseline Fan Efficacy

Fan Location	Airflow Rate Minimum (CFM)	Minimum Efficacy (CFM/Watt)
HRV,ERV	Any	1.2
In-line supply or exhaust fan	Any	3.8
Other exhaust fan	<90	2.8
Other exhaust fan	>= 90	3.5
Unknown	Any	2.8

Table 2-94 Peak Outdoor Air Temperature and Enthalpy

NJ Climate Region	Peak outdoor temperature during cooling season, $T_{outdoor,c,peak}$ (°F)	Peak Enthalpy of outdoor air at duing cooling season, $H_{outdoor,c,peak}$ (Btu/lb)
Northern	89	40.24
Southwest	93	42.28
Coastal	90	41.26
Central	93	42.28
Pine Barrens	94	41.22
Statewide Average	92	41.65

Peak Factors

Table 2-95 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[118]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 14 years [119].

References

[117] Performance Rating of air-to-air exchanges for Energy Recovery Ventilation Equipment, AHRI, December 2022. http://www.ahrinet.org/ERVcertification

[118] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, and supported by research conducted by Cadmus on behalf of the RM Management Committee, September 2011.

[119] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report, August 2009 https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

[120] ONJSC: Monthly/Annual Temperature Normals (1991-2020), December 2022 http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html.

[121] NSRDB, TMY3 data, December 2022. https://nsrdb.nrel.gov/data-sets/tmy

[122] *Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors*, Cascade Energy, November 5, 2012. Table 6: Load Factor by Nameplate hp and End Use. November 5, 2012

[123] "2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES." n.d. Table C403.8.5. Codes.iccsafe.org. Accessed November 16, 2022. https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency.

[124] ASHRAE Fundamentals 2021 - Chapter 14 Climactic Design Conditions - https://handbook.ashrae.org/Handbook.aspx#. Peak temperature and enthalpy taken from data from representative weather stations for each NJ climate zone.

2.3.8 MAINTENANCE

Market	Residential /Multifamily
Baseline Type	RF
Baseline	Existing
End Use Subcategory	Maintenance
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for existing HVAC maintenance in residential applications.

For gas applications, a tune-up of residential fossil fuel space heating boilers or furnaces results in improved seasonal heating efficiency. A tune-up typically involves inspection, cleaning the heating unit of dust and dirt, checking safety components, and/or adjustment of boiler and appurtenances per manufacturer's recommendations.

A gas savings calculation requires measurement of steady state furnace or boiler efficiency before and after maintenance using an electronic combustion analyzer. Alternatively, before and after maintenance efficiencies may be measured following the method described in ANSI/ASHRAE Standard 103-2007, Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers. Maximum post-maintenance efficiency must not exceed equipment nameplate efficiency. Technicians performing maintenance must provide documentation of before- and after-combustion analysis results.

Electric Units such as Central A/C and heat pumps also benefit greatly from tune ups. A tune up typically includes cleaning filters, inspecting bearings, verification of refrigerant charge and correct, if necessary, clean condenser, and if accessible, evaporator coil.

Note that gas savings calculations (therms) are only applicable for gas units, whereas electric saving calculations are only applicable for electric units.

Baseline Case

Gas: Residential fossil fuel space heating boiler or furnace in a single family or low-rise *Multifamily* building that has not received a tune-up in 5 years or more.

Electric: An existing central A/C, air source heat pump, ground source heat pump, ductless mini-split heat pump, mini-split AC, PTAC, or PTHP unit that has not received a tune-up in 5 years or more.

Efficient Case

Gas: Residential fossil fuel space heating boiler or furnace that has undergone a tune-up in accordance with the manufacturer's recommendations.

Electric: Electric unit after receiving tune-up.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_c + \Delta kWh_h$$

Where,

$$\Delta kWh_c = \frac{Cap_c}{SEER} \times SF \times EFLH_c$$

$$\Delta kWh_h = \frac{Cap_h}{HSPF} \times SF \times EFLH_h$$

For geothermal heat pumps:

$$SEER = EER_g \times GSHPDF \times GSER$$

$$HSPF = COP_g \times GSHPDF \times 3.412$$

For PTAC and PTHP:

$$SEER = EER$$

Annual Fuel Savings

$$\Delta Therms = Cap_{in} \times ELFH_h \times \frac{\left(\frac{1}{SSE_b} - \frac{1}{SSE_q}\right)}{100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{Cap_c}{EER} \times SF \times CF$$

For geothermal heat pumps:

$$EER = EER_g \times GSPK$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-96 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔkWh_c	Annual electric cooling energy savings	Calculated	kWh/yr	
ΔkWh_h	Annual electric heating energy savings	Calculated	kWh/yr	
SSE_b	Steady state efficiency of baseline gas HVAC equipment	Site-specific	N/A	
SSE_q	Steady state efficiency of repaired gas HVAC equipment	Site-specific	N/A	
Cap_c	Cooling Capacity of electrical unit receiving tune-up	Site-specific	kBtu/hr	
Cap_h	Heating Capacity of electrical unit receiving tune-up	Site-specific	kBtu/hr	
Cap_{in}	Input capacity of unit receiving tune-up	Site-specific	kBtu/hr	
EER	Energy Efficiency Ratio of unit receiving tune-up	Site-specific. If unknown, see Appendix E: Code-Compliant Efficiencies	Btu/W-h	[128]
EER_g	Full Load Energy Efficiency Ratio of ground source heat pump receiving tune up (this is measured differently than EER of an ASHP and must be converted)	Site-specific	Btu/W-h	
SEER/EER/HSPF/SEER2, EER2, HSPF2	Efficiency of unit receiving tune-up	Site-specific. If unknown, see Appendix E: Code-Compliant Efficiencies	Btu/W-h	[128]

Variable	Description	Value	Units	Ref
COP_g	Full Load coefficient of Performance of ground source heat pump receiving tune-up	Site-specific	N/A	
HSPF	Heating Seasonal Performance Factor of unit receiving tune-up	Site-specific. If unknown, see Appendix E: Code-Compliant Efficiencies	Btu/W-h	[128]
SF	Savings factor, assumed savings due completion of tune up[26]	0.05	N/A	[134]
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	[125]
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season[27]	Lookup in Appendix C: Heating and Cooling EFLH	Hours	[127]
GSER	Factor used to determine the SEER of a GSHP based on its EER_g	1.02	Btu/W-h	
GSPK	Factor to convert EER_g to the equivalent EER of an air conditioner to enable comparisons to the baseline unit	0.8416	N/A	
GSHPDF	Ground Source Heat Pump De-rate Factor	0.885	N/A	
3.412	Conversion from Btu to W-h	3.412	Btu/W-h	
CF	Electric coincidence factor	Look up in Table 2-97	N/A	
PDF	Gas peak day factor	Look up in Table 2-97	N/A	
EUL	Estimated useful life	Look up in Table 2-98	Years	
100	Conversion from kBtu to therms	100	kBtu/Therms	

[26] VEIC estimate. Extrapolation of manufacturer data.
[27] VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.

Peak Factors

Table 2-97 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[126]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Measure life is dependent on the gas/electric equipment receiving a tune-up.

Table 2-98 Measure Life

Equipment	EUL	Ref
Air Conditioner – Room (RAC)	12	[129]
Air Conditioner – Central (CAC)	15	[130]
Air Conditioner – PTAC	15	[130]
Boiler, Hot Water – Steel Water Tube	24	[131]
Boiler, Hot Water – Steel Fire Tube	25	[131]
Boiler, Hot Water – Cast Iron	35	[131]
Boiler, Steam – Steel Water Tube	30	[131]
Boiler, Steam – Steel Fire Tube	25	[131]
Boiler, Steam – Cast Iron	30	[131]
Furnace, Gas Fired	22	[132]
Gas Heat Pump	15	[130]
Heat Pump - Air Source (ASHP)	15	[130]
Heat Pump – Ground Source (GSHP)	25	[133]
Heat Pump – PTHP	15	[130]
Ductless Mini-Split	15	[135]

References

[125] NJ utility analysis of heating customers, annual gas usage.
[126] NEEP, *Mid-Atlantic Technical Reference Manual*, *V10* (May 2020).
[127] VEIC estimate.
[128] NMR Group, Inc., *2018 Pennsylvania Statewide Act 129 Residential Baseline Study* (Feb 2018). https://www.puc.pa.gov/Electric/pdf/Act129/SWE-Phase3_Res_Baseline_Study_Rpt021219.pdf

[129] GDS Associates, Inc., *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures* (June 2007) Table 1 – Residential Measures.

[130] DEER 2014 EUL. http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

[131] ASHRAE Handbook, 2015.

[132] U.S. DOE. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces* and *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces* (2016). https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0217

[133] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey. https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1

[134] *Residential HVAC Installation Practices: A Review of Research Findings* (US DOE, 2018), Pg 5. https://www.energy.gov/eere/buildings/articles/residential-hvac-installation-practices-review-research-findings

[135] Based on 2016 DOE Rulemaking Technical Support Document, as recommended in Navigant 'ComEd Effective Useful Life Research Report', May 2018. https://www.icc.illinois.gov/docket/P2017-0312/documents/287811/files/501915.pdf

2.3.9 BOILER CONTROLS

Market	Residential/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use	HVAC
Measure Last Reviewed	December 2022

Description

This measure applies to the installation of reset controls to a residential heating boiler to adjust the boiler water temperature based on the outdoor air temperature. A boiler reset control has two temperature sensors - one outside the house and one in the boiler water. As the outdoor temperature rises and falls, the control adjusts the water temperature to the lowest setting required to meet heating demand.

The input values are based on data supplied by the utilities and customer information on the application form, confirmed with manufacturer data. Unit savings are based on study results.

Baseline Case

Existing boiler without reset controls.

Efficient Case

Installation of boiler reset controls. The system's minimum temperature setpoint must be set no more than 10 degrees above manufacturer's recommended minimum return temperature.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = SF \times \frac{EFLH_h \times Cap_{in}}{100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = N/A$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-99 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
Cap_{in}	Input capacity of boiler	Site specific	kBtu/hr	
SF	Savings factor, estimated percent reduction in heating load due to controls being installed.	0.05	N/A	[136]
$EFLH_h$	Estimated full load hours for heating	Lookup in Appendix C: Heating and Cooling EFLH	hrs	[137]
EUL	Effective useful life	Lookup in Table 2-101	Years	
PDF	Peak day factor	Lookup in Table 2-100		
100	Conversion from kBtu to therm	100	kBtu	

Peak Factors

Table 2-100 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) of boiler controls is the smaller of to the remaining useful life (RUL) of the boiler or 7.33 years. If boiler RUL is unknown, assume 1/3 of the boiler EUL.

Table 2-101 Measure Life

Equipment	EUL	RUL	Ref
Boiler, Hot Water – Steel Water Tube	24	8	[138]
Boiler, Hot Water – Steel Fire Tube	25	8.33	[482]
Boiler, Hot Water – Cast Iron	35	11.67	[482]
Boiler, Steam – Steel Water Tube	30	10	[482]
Boiler, Steam – Steel Fire Tube	25	8.33	[482]
Boiler, Steam – Cast Iron	30	10	[482]

References

[136] GDS Associates, Inc. Natural Gas Energy Efficiency Potential in Massachusetts, 2009, p. 38 Table 6-4. https://ma-eeac.org/wp-content/uploads/5_Natural-Gas-EE-Potenial-in-MA.pdf

[137] Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.

[138] ASHRAE Handbook, 2015.

2.3.10 FILTER WHISTLE

Market	Residential/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Filter Whistle
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for filter whistles on air handlers installed in residential settings. Dirty air handler filters result in increases energy consumption for the circulation fan and decreases system heating and cooling efficiency. These whistles attach to the filter of the air handler and make a sound when it is time to replace the filter.

Savings estimates are based on reduced blower fan motor power requirements for winter and summer use of the blower fan motor. This air handler filter whistle measure applies to central forced-air furnaces, central AC and heat pump systems. Where homes do not have central cooling, only the annual heating savings will apply.

Baseline Case

Air Handler Filter without Filter Whistle

Efficient Case

Air Handler Filter with Filter Whistle to promote regular replacement of filter

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{heat} + \Delta kWh_{cool}$$

Where,

$$kW_{motor} = HP \times 0.746$$

$$\Delta kWh_{heat} = kW_{motor} \times EFLH_h \times EI \times ISR$$

$$\Delta kWh_{cool} = kW_{motor} \times EFLH_c \times EI \times ISR$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh_{cool}}{EFLH_c} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-102 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔkWh_h	Annual heating electric energy savings	Calculated	kWh/yr	
ΔkWh_c	Annual cooling electric energy savings	Calculated	kWh/yr	
kW_{motor}	Motor full load electric demand	Calculated, if HP is unknown use 0.377	kW	
HP	Horsepower of blower motor	Site specific, if unknown use 0.5[28]	HP	

[28] Typical blower motor capacity for gas furnace is ¼ to ¾ HP, Avg of ½ HP =0.377kW.

Variable	Description	Value	Units	Ref
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	[139]
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	[140]
EI	Efficiency Improvement	15%	N/A	[141]
ISR	In-service rate	Look up by program in Appendix J: In-Service Rates, or use default values: Default for Kits = 15%, Default for Direct Install = 100%	N/A	[142]
CF	Electric coincidence factor	Look up in Table 2-103	N/A	
PDF	Gas peak demand factor	Look up in Table 2-103	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[144]
0.746	Conversion factor for HP to kWh	0.746	kW/HP	

Peak Factors

Table 2-103 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[143]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-104 Measure Life

Equipment	EUL	RUL	Ref
Filter Whistle	5	1.67	[144]

References

[139] NJ utility analysis of heating customers, annual gas usage

[140] VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.

[141] Energy.gov *Maintaining Your Air Conditioner* (Accessed 12/16/2022), Says that replacing a dirty air filter with a clean one can lower total air conditioner energy consumption by 5-15%. Since the algorithms in this measure only take into account the blower fan energy use, a 15% savings seems reasonable. https://www.energy.gov/energysaver/maintaining-your-air-conditioner

[142] The In Service Rate is the average of values reported by FirstEnergy EDCs for kits including an air handler furnace whistle for PY9.

http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/electric_distribution_company_act_129_reporting_requirements.aspx

[143] Per NY TRM: "Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011 and supported by research conducted by Cadmus on behalf of the RM Management Committee."

[144] DEER 2020 http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

2.3.11 CEILING FAN

Market	Residential/Multifamily
Baseline Condition	TOS/DI
Baseline	Existing/Dual
End Use Subcategory	Ceiling Fan
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for the installation of an ENERGY STAR v4.0 ceiling fan/light unit in residential settings. These units are known to be 60% more efficient than conventional units due to improved motors and blade design [145].

Since the savings from this measure are derived from more efficient ventilation and lighting, which have very different load shapes and measure life, the savings are split by component and claimed together.

Baseline Case

Conventional ceiling fan/light unit with EISA qualified incandescent or halogen light bulbs.

Efficient Case

An ENERGY STAR v4.0 certified ceiling fan/lighting unit with LED bulbs.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{fan} + \Delta kWh_{light}$$

Where,

$$\Delta kWh_{fan} = \frac{\text{Days} \times Hrs_{fan} \times \left[\left(F_{low,b} \times W_{low,b}\right) + \left(F_{med,b} \times W_{med,b}\right) + \left(F_{high,b} \times W_{high,b}\right)\right]}{1{,}000} - \frac{\text{Days} \times Hrs_{fan} \times \left[\left(F_{low,q} \times W_{low,q}\right) + \left(F_{med,q} \times W_{med,q}\right) + \left(F_{high,q} \times W_{high,q}\right)\right]}{1{,}000}$$

$$\Delta kWh_{light} = \frac{W_{b,light} - W_{q,light}}{1{,}000} \times Hrs_{light} \times (1 + HVAC_e)$$

Annual Fuel Savings

Heating Penalty from improved lighting:

$$\Delta Therms = -\frac{W_{b,light} - W_{q,light}}{1{,}000} \times Hrs_{light} \times HF \times \frac{0.03412}{Eff_{heat}} \times F_{FH}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kW_{fan} + \Delta kW_{light}$$

Where,

$$\Delta kW_{fan} = \frac{W_{high,b} - W_{high,q}}{1{,}000} \times CF_{fan}$$

$$\Delta kW_{light} = \frac{W_{b,light} - W_{q,light}}{1{,}000} \times CF_{light} \times (1 + HVAC_d)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-105 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{fan}	Annual ceiling fan savings	Calculated	kWh/yr	

Variable	Description	Value	Units	Ref
ΔkWh_{light}	Annual light savings	Calculated	kWh/yr	
ΔkW_{fan}	Annual fan peak demand savings	Calculated	kW	
ΔkW_{light}	Annual light peak demand savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
Days	Days used per year	Site-specific, if unknown use 365.25	Days/yr	[148]
Hrs_{fan}	Daily Fan "On Hours"	Site-specific, if unknown use 3	Hrs/day	[148]
$W_{low,b}$	Fan wattage at Low speed of baseline	Site-specific, if unknown use 15	Watts	[148]
$W_{med,b}$	Fan wattage at Medium speed of baseline	Site-specific, if unknown use 34	Watts	[148]
$W_{high,b}$	Fan wattage at High speed of baseline	Site-specific, if unknown use 67	Watts	[148]
$W_{low,q}$	Fan wattage at Low speed of ENERGY STAR	Site-specific, if unknown use 6	Watts	[148]
$W_{med,q}$	Fan wattage at Medium speed of ENERGY STAR	Site-specific, if unknown use 23	Watts	[148]
$W_{high,q}$	Fan wattage at High speed of ENERGY STAR	Site-specific, if unknown use 56	Watts	[148]
$W_{b,light}$	Total lighting wattage of baseline fixture	Site-specific; if unknown use 129W	Watts	[148]
$W_{q,light}$	Total lighting wattage of energy efficient fixture	Site-specific; if unknown use 42W	Watts	[148]
F_{FH}	Fraction of homes using fossil fuel heat	Site-specific; if unknown use 0.8	N/A	
$F_{low,b}$	Fraction of time spent at Low speed of baseline	0.4	N/A	[148]
$F_{med,b}$	Fraction of time spent at Medium speed of baseline	0.4	N/A	[148]
$F_{high,b}$	Fraction of time spent at High speed of baseline	0.2	N/A	[148]
$F_{low,q}$	Fraction of time spent at Low speed of ENERGY STAR	0.4	N/A	[148]
$F_{med,q}$	Fraction of time spent at Medium speed of ENERGY STAR	0.4	N/A	[148]

Variable	Description	Value	Units	Ref
$F_{high,q}$	Fraction of time spent at High speed of ENERGY STAR	0.2	N/A	[148]
1,000	Conversion from W to kW	1,000	W/kW	
Hrs_{light}	Lighting hours of operation	Look up in Table 2-106	Hrs/yr	[146][147]
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 2-106	N/A	[146]
$HVAC_d$	HVAC Interactive Factor for Peak Demand Savings	Look up in Table 2-106	N/A	[146]
HF	Heating Factor	0.47	N/A	
Eff_{heat}	Efficiency of heating system	0.8	N/A	
CF	Electric coincidence factor	Look up in Table 2-107	N/A	
PDF	Gas peak demand factor	Look up in Table 2-107	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 2-106 Lighting Hours, Interactive Factors

Installation Location	Hrs	$HVAC_e$[29]	$HVAC_d$[30]
Interior	679	0.023	0.155
Exterior	1643	0	0
Unknown	808	0.020	0.134

Peak Factors

Table 2-107 Peak Factors

Peak Factor	Value	Ref
Fan coincidence factor (CF_{fan})	0.3	[149]
Light coincidence factor (CF_{light})	0.06	[146]
Natural gas peak day factor (PDF)	N/A	N/A

[29] For electric cooling interactivity, value based on NEEP Mid-Atlantic TRM V9, p. 22: Calculated using defaults assuming 89% of homes have electric cooling (per RECS 2015 data) with an average 3.8 COP and a cooling load reduction of 33% of lighting savings; 0.89*(0.33 / 3.8) = 0.077.
For electric heating interactivity, value based on NEEP Mid-Atlantic TRM V9, p. 22: Calculated using defaults assuming 20% of homes are electrically heated (per RECS 2015 data) with an average 1.74 COP and a heating load increase of 47% of lighting savings; -0.20*(0.47 / 1.74) = -0.054. Value of $HVAC_e$ established as the summation of these values; 0.077 – 0.054 = 0.023.

[30] From NEEP Mid-Atlantic TRM V9, p. 24: Calculated using defaults assuming 89% of homes have electric cooling (per RECS 2015 data) with an average 3.8 COP and peak cooling load reduction of 66% of lighting savings; 0.89*(0.66 / 3.8) = 0.155.

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-108 Measure Life

Equipment	EUL	RUL	Ref
Ceiling Fan	15	5	[146]

References

[145] "Ceiling Fans." n.d. Www.energystar.gov. https://www.energystar.gov/products/ceiling_fans.

[146] "MID-ATLANTIC TECHNICAL REFERENCE MANUAL VERSION 9." n.d. Accessed November 23, 2022. https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf .

[147] DNV KEMA Energy and Sustainability, Pacific Northwest National Laboratory, *Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates*. (US DOE, 2012), Table 4.4, https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf

[148] https://www.energystar.gov/sites/default/files/asset/document/light_fixture_ceiling_fan_calculator.xlsx

[149] Assuming that the CF for a ceiling fan is the same as Room AC; Consistent with coincidence factors found in: *RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners*, (June 23, 2008) http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/117_RLW_CF%20Res%20RAC.pdf

2.3.12 SMART THERMOSTAT

Market	Residential/Multifamily
Baseline Condition	RF/DI/TOS
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure covers the installation of Smart or Connected ENERGY STAR® V1.0[31] thermostats applied to single-family and multifamily residential HVAC systems. A "smart" thermostat that is ENERGY STAR® certified has the following properties [152].

- Automatic scheduling
- Occupancy sensing (set "on" as a default)
- For homes with a heat pump, smart thermostats must be capable of controlling heat pumps to optimize energy use and minimize the use of backup electric resistance heat.
- Ability to adjust settings remotely via a smart phone or online the absence of connectivity to the connected thermostat (CT) service provider, retain the ability for residents to locally:
    - View the room temperature,
    - View and adjust the set temperature, and
    - Switch between off, heating and cooling
- Have a static temperature accuracy ≤ ± 2.0 °F
- Have network standby average power consumption of ≤ 3.0 W average (Includes all equipment necessary to establish connectivity to the CT service provider's cloud, except those that can reasonably be expected to be present in the home, such as Wi-Fi routers and smart phones.)
- Enter network standby after ≤ 5.0 minutes from user interaction (on device, remote or occupancy detection)
- The following capabilities may be enabled through the CT device, CT service or any combination of the two. The CT product shall maintain these capabilities through subsequent firmware and software changes.
    - Ability for consumers to set and modify a schedule.
    - Provision of feedback to occupants about the energy impact of their choice of settings.

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[31] ENERGY STAR® V2.0 Connected Thermostats is under development.

- Ability for consumers to access information relevant to their HVAC energy consumption, e.g. HVAC run time.

Baseline Case

Mix of standard non-programmable and programmable thermostats for central heating and cooling systems

Efficient Case

Smart Thermostat meeting the measure description above.

Annual Energy Savings Algorithms

Note: Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cool} + \Delta kWh_{heat}$$

Where,

$$\Delta kWh_{cool} = \left(Cap_c \times EFLH_{cool} \times \frac{1}{SEER2} \times SF_{elec,c} \times F_{elecCool}\right)$$

$$\Delta kWh_{heat} = \left(Cap_{h,out} \times EFLH_{heat} \times \frac{1}{HSPF2} \times SF_{elec,h} \times F_{elecHeat}\right)$$

Annual Fuel Savings

$$\Delta Therms = Cap_{h,fuel} \times EFLH_{heat} \times \frac{1}{AFUE} \times SF_{fuel} \times F_{fuelHeat} \times \frac{1}{100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-109 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔkWh_{cool}	Cooling electric savings	Calculated	kWh/yr	
ΔkWh_{heat}	Heating electric savings	Calculated	kWh/yr	
Cap_c	Cooling capacity per residence	Site-specific, if unknown use 36 kBTU/hr[32]	Tons/unit	[157]
SEER2	Seasonal energy efficiency ratio of cooling unit	Site-specific, if unknown, look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[150]
$EFLH_{cool}$	Equivalent full load hours of operation during cooling season	Look up in Appendix C: Heating and Cooling EFLH	Hours	[151]
$SF_{elec,c}$	Cooling energy savings factor	0.07	N/A	[155]
$F_{elecCool}$	Electric cooling factor; used to account for the presence or absence of an electric cooling system	Electric Cooling: 1 No Electric Cooling: 0 Unknown: 0.39	N/A	[153]
$Cap_{h,out}$	Output heating capacity in kBTU/h per residence	Site-specific, if unknown use 72 kBTU/hr[33]	kBTU/hr	[157]

[32] Assumes a 1,800 ft^2 home with 20 BTU/h-ft2 cooling load: 1,800 ft2 x 20 BTU/h-ft2 x 1/(1,000 kBTU/h)/(BTU/h) = 36 kBTU/h
[33] Assumes a 1,800 ft^2 home with 40 BTU/h-ft2 heating load: 1,800 ft2 x 40 BTU/h-ft2 x 1/(1,000 kBTU/h)/(BTU/h) = 72 kBTU/h

Variable	Description	Value	Units	Ref
$Cap_{h,fuel}$	Heating capity in of existing fossil heat unit	Site-specific	kBTU/hr	
HSPF2	Heating seasonal performance factor of heating unit. If rated in COP, convert using HSPF = COP x 3.412	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[150]
$EFLH_{heat}$	Equivalent full load hours of operation during heating season	Look up in Appendix C: Heating and Cooling EFLH	Hours	[151]
AFUE	Annual fuel utilization efficiency	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	N/A	[150]
SF_{fuel}	Fuel heating energy savings factor	0.06	N/A	[155]
$SF_{elec,h}$	Electric heating energy savings factor	0.06	N/A	[155]
$F_{elecHeat}$	Electric heating factor; used to account for the presence or absence of an electric heating system	Electric Heating: 1 No Electric Heating: 0 Unknown: look up by program in Appendix K: DHW and Space Heat Fuel Split, or default = 0.15	N/A	[154]
$F_{FuelHeat}$	Fossil fuel heating factor; used to account for the presence or absence of a fossil fuel heating system	Fossil Fuel Heating: 1 No Fossil Fuel Heating: 0 Unknown: look up by program in Appendix K: DHW and Space Heat Fuel Split, or default = 0.95	N/A	[154]
100	Conversion factor, kBTU to therms	100	kBTU/therms	
CF	Electric coincidence factor	Look up in Table 2-110	N/A	
PDF	Gas peak day factor	Look up in Table 2-110	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 2-110 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

This measure is being applied to existing operational equipment. Hence, the effective useful life (EUL) is the smaller of the host equipment remaining useful life (RUL) or 5 years [156]. If host equipment RUL is unknown, assume 1/3 of the host equipment EUL (look up in relevant HVAC measure).

References

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[151] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[152] *ENERGY STAR® Program Requirements Product Specification for Connected Thermostat Products, Eligibility Criteria Version 1.0*, (January 2017), pg. 10 https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf

[153] EIA Residential Energy Consumption Survey (RECS) 2015 for Middle Atlantic States, Table HC7.7 https://www.eia.gov/consumption/residential/data/2015/hc/php/hc7.7.php ("Unknown" calculated as the number of homes with central AC divided by the total number of homes).

[154] EIA Residential Energy Consumption Survey (RECS) 2015 for Middle Atlantic States, Table HC6.7 https://www.eia.gov/consumption/residential/data/2015/hc/php/hc6.7.php ("Unknown" calculated as the number of homes with electric heat divided by the total number of homes).

[155] *TRM Mid-Atlantic Technical Reference Manual:Version 10* (NEEP, 2020), Pg 104, https://neep.org/mid-atlantic-technical-reference-manual-trm-v10

[156] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[157] From NY TRM V10, Pg 308

2.4 LIGHTING

2.4.1 LAMPS AND FIXTURES

Market	Residential/Multifamily
Baseline Condition	TOS/NC/RF/EREP/ERET/DI
Baseline	Existing/Code
End Use Subcategory	Lighting
Measure Last Reviewed	November 2022

Description

This section provides energy saving algorithms for the installation of screw-in ENERGY STAR LED general service lamps, ENERGY STAR LED fixtures, ENERGY STAR specialty LED lamps, Nightlights, and Holiday Lights.

Savings from lamps and fixtures are based on the difference between the baseline lamp/fixture wattage and new lamp/fixture wattage, and the average daily hours of usage for the lighting unit being replaced.

For ENERGY STAR Lamps, baseline lamp/fixture wattage is based on the lumen output of the ENERGY STAR lamp/fixture and a minimum lamp/fixture lumen per watt efficacy. Using the relationship in this section, the baseline lamp wattage for General Service Lamps is installed lumens divided by 45 lumens per watt, compliant with Federal regulations issued on May 8, 2022 and New Jersey P.L. 2021, c. 464 minimum standards[165]. Full compliance with this standard by retailers shall commence on August 1, 2023[164].

Baseline Case

ENERGY STAR Lamps and Fixtures: Baseline wattage assumed to equal to the installed lumens divided by 45 lumens per watt for general service bulbs in kits and retail distribution. For direct install lights exempt from or installed prior to enforcement of the EISA requirement, if the site-specific baseline wattage is unknown, use the baseline wattage assumptions in Table 2-113, Table 2-114, and Table 2-115.

Nightlights: Non LED Nightlights, assumed 6.75 watts.

Holiday Lights: Traditional incandescent holiday lights with a wattage higher than the LED wattage. For incandescent mini-bulbs, incandescent C7 bulbs, and incandescent C9 bulbs, assume baselines of 0.48, 6, and 7 watts per bulb respectively.

Efficient Case

ENERGY STAR Lamps and Fixtures: Qualifying Lamp/Fixture ENERGY STAR wattage

Nightlights: Qualifying LED Nightlight wattage.

Holiday Lights: Qualifying LED Holiday Lights wattage.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

ENERGY STAR Lamps and Fixtures:

$$\Delta kWh = N_q \times \frac{W_{b,ES} - W_{q,ES}}{1{,}000} \times Hrs_{ES} \times (1 + HVAC_e) \times ISR$$

Where,

$$W_{b,ES} = \frac{Lumen_q}{45}$$

Nightlights:

$$\Delta kWh = \frac{W_{NL} \times H_{NL,daily} \times 365}{1{,}000}$$

Holiday Lights:

$$\Delta kWh = [F_{C9} \times \Delta kWh_{C9}] + [F_{C7} \times \Delta kWh_{C7}] + [F_{mini} \times \Delta kWh_{mini}]$$

Where,

$$\Delta kWh_{C9} = \frac{\left[\left(W_{b,C9} - W_{q,C9}\right) \times N_{bulbs} \times N_{strands} \times Hrs_{HL}\right]}{1{,}000}$$

$$\Delta\, kWh_{C7} = \frac{\left[\left(W_{b,C7} - W_{q,C7}\right) \times N_{bulbs} \times N_{strands} \times Hrs_{HL}\right]}{1{,}000}$$

$$\Delta\, kWh_{mini} = \frac{\left[\left(W_{b,mini} - W_{q,mini}\right) \times N_{bulbs} \times N_{strands} \times Hrs_{HL}\right]}{1{,}000}$$

Annual Fuel Savings

ENERGY STAR Lamps and Fixtures:

$$\Delta Therms = -\, N_q \times \frac{W_{b,ES} - W_{q,ES}}{1{,}000} \times Hrs \times HVAC_g \times \frac{0.03412}{Eff_{heat}} \times F_{FH}$$

No fuel savings associated with Nightlights and Holiday Lights.

Peak Demand Savings

ENERGY STAR Lamps and Fixtures:

$$\Delta kW_{Peak} = N_q \times \frac{W_{b,ES} - W_{q,ES}}{1{,}000} \times CF \times (1 + HVAC_d)$$

No Peak Demand Savings associated with Nightlights and Holiday Lights.

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-111 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
N_q	Quantity of energy efficient fixtures	Site-specifc	N/A	
$W_{b,ES}$	Wattage of baseline fixture	EISA Compliant: Calculated based on algorithm above Exempt from EISA Compliance: Site-specific, if unkown look up in Table 2-113, Table 2-114, Table 2-115	kW	[168]
$W_{q,ES}$	Wattage of energy efficient fixture	Site-specifc	kW	
$Lumens_q$	Lumens of energy efficient fixture	Site-specific	Lumens	
F_{mini}	Percentage of holiday lights that are "mini"	Site-specific, if unknown use 0.5	%	[162]
F_{C7}	Percentage of holiday lights that are "C7"	Site-specific, if unknown use 0.25	%	[162]
F_{C9}	Percentage of holiday lights that are "C9"	Site-specific, if unknown use 0.25	%	[162]
N_{bulbs}	Number of bulbs per strand	Site-specific, if unknown use 50	Bulbs/Strand	[163]
$N_{strands}$	Number of strands of lights per package	Site-specific, if unknwon use 1	Strands/package	[163]
Hrs_{ES}	Annual Hours of Operation	Look up in Table 2-112	Hrs/yr	[158][159]

Variable	Description	Value	Units	Ref
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 2-112	N/A	[158]
$HVAC_d$	HVAC Interactive Factor for Peak Demand Savings	Look up in Table 2-112	N/A	[158]
$HVAC_g$	Heating factor, or percentage of lighting savings that must be heated	Look up in Table 2-112	N/A	[158]
ISR	In-service rate	Look up by program in Appendix J: In-Service Rates, or use default value = 0.92	N/A	
Eff_{heat}	Efficiency of heating system	0.8	N/A	[167]
F_{FH}	Fraction of homes using fossil fuel heat	0.8	N/A	[166]
W_{NL}	Average watts replaced for an LED nightlight installation	6.75	W	[160]
$Hrs_{NL,daily}$	Average daily burn time for LED nightlight replacements	12	hrs	[161]
365	Days per year	365	Day/yr	
1,000	Conversion from watts to kW	1,000	W/kW	
0.03412	Conversion factor	0.03412	Therms/kWh	
$W_{q,mini}$	Wattage of LED mini bulbs	0.08	W/Bulb	[162]
$W_{b,mini}$	Wattage of incandescent mini bulbs	0.48	W/Bulb	[162]
$W_{q,C7}$	Wattage of LED C7 bulbs	0.48	W/Bulb	[162]
$W_{b,C7}$	Wattage of incandescent C7 bulbs	6	W/Bulb	[162]
$W_{q,C9}$	Wattage of LED C9 bulbs	2	W/Bulb	[162]
$W_{b,C9}$	Wattage of incandescent C9 bulbs	7	W/Bulb	[162]
45	Conversion from lumens of energy efficient fixture to wattage of baseline fixture	45	Lumens/watt	
Hrs_{HL}	Annual hours of operation for Holiday Lights	150	Hrs/yr	[162]
CF	Electric coincidence factor	Look up in Table 2-116	N/A	
PDF	Gas peak day factor	Look up in Table 2-116	N/A	
EUL	Effective useful life	See	Years	

Table 2-112 Hours, Interactive Factors, and Heating Factor

Installation Location	Hrs	$HVAC_e$[34]	$HVAC_d$[35]	$HVAC_g$
Interior	679	0.023	0.155	0.47
Exterior	1643	0	0	0
Unknown	808	0.020	0.134	0.41

Table 2-113 Exempt Standard Lamp Baselines

Bulb Type	Lumen Range	$W_{b,ES}$
A-Lamp (A15, A17, A19, A21)	< 310	Use ENERGY STAR Watts Equivalent
	310 – 749	40
	750 – 1,049	60
	1,050 – 1,489	75
	1,490 – 2,600	100
	> 2,600	Use ENERGY STAR Watts Equivalent

Table 2-114 Exempt Specialty Lamps Baseline

Bulb Type	Base Type	Lumen Range	$W_{b,ES}$
Globe All G (G30, G25, G16.5)	E26 and E17	< 90	Use ENERGY STAR Watts Equivalent
		90 – 179	10
		180 – 249	20
		250 – 349	25
		350 – 749	40
		750 – 1,049	43
		1,050 – 1,489	53
		1,490 – 2,600	72
		> 2,600	Use ENERGY STAR Watts Equivalent
	E12 (Candelabra)	< 90	Use ENERGY STAR Watts Equivalent
		90 – 179	10
		180 – 249	20
		250 – 349	25
		350 – 499	40
		500 – 1,049	60

[34] For electric cooling interactivity, value based on NEEP Mid-Atlantic TRM V9, p. 22: Calculated using defaults assuming 89% of homes have electric cooling (per RECS 2015 data) with an average 3.8 COP and a cooling load reduction of 33% of lighting savings; 0.89*(0.33 / 3.8) = 0.077.
For electric heating interactivity, value based on NEEP Mid-Atlantic TRM V9, p. 22: Calculated using defaults assuming 20% of homes are electrically heated (per RECS 2015 data) with an average 1.74 COP and a heating load increase of 47% of lighting savings; -0.20*(0.47 / 1.74) = -0.054. Value of $HVAC_e$ established as the summation of these values; 0.077 – 0.054 = 0.023.

[35] From NEEP Mid-Atlantic TRM V9, p. 24: Calculated using defaults assuming 89% of homes have electric cooling (per RECS 2015 data) with an average 3.8 COP and peak cooling load reduction of 66% of lighting savings; 0.89*(0.66 / 3.8) = 0.155.

Bulb Type	Base Type	Lumen Range	$W_{b,ES}$
		> 1,049	Use ENERGY STAR Watts Equivalent
Globe (G40)	E26 (Medium), E17, and E12	< 90	Use ENERGY STAR Watts Equivalent
		90 – 179	10
		180 – 249	20
		250 – 349	25
		350 – 499	40
		500 – 1,049	60
		> 1,049	Use ENERGY STAR Watts Equivalent

Bulb Type	Base Type	Lumen Range	$W_{b,ES}$
Decorative (Shapes B10, B11, B13, BA10, BA11, CA10, C7, C9, F10, F15, ST, S14)	E26 (Medium) and E17	< 70	Use ENERGY STAR Watts Equivalent
		70 – 89	10
		90 – 149	15
		150 – 299	25
		300 – 749	40
		750 – 1,049	43
		1050 – 1,489	53
		1,490 – 2,600	72
		> 2,600	Use ENERGY STAR Watts Equivalent
	Candelabra base E12	< 70	Use ENERGY STAR Watts Equivalent
		70 – 89	10
		90 – 149	15
		150 – 299	25
		300 – 449	40
		450 – 1,049	60
		> 1,049	Use ENERGY STAR Watts Equivalent

Table 2-115 Exempt Reflector/Flood Lamps Baseline

Bulb Type	Lumen Range	$W_{b,ES}$
R20	200 - 299	30
	300 – 718	45
	719 – 810	50
	811 – 1,002	55
	1,003 – 1,202	65
	1,203 – 1,516	75
	1,517 – 1,733	90
	1,734 – 2,184	100
	> 2,184	120
PAR20	200 - 299	30
	300 – 718	40
	719 – 810	50
	811 – 1,002	55
	1,003 – 1,202	65
	1,203 – 1,516	75
	1,517 – 1,733	90
	1,734 – 2,184	100

Bulb Type	Lumen Range	$W_{b,ES}$
	> 2,184	120
BR30, BR40, ER40	200 – 299	30
	300 – 399	40
	400 – 649	50
	650 – 1,419	65
	1,420 – 1,789	75
	1,790 – 2,045	90
	2,046 – 2,578	100
	> 2,578	120
ER30	200 – 299	30
	300 – 399	40
	400 – 956	50
	957 – 1183	55
	1184 – 1419	65
	1420 – 1789	75
	1790 – 2045	90
	2046 – 2578	100
	> 2578	120
PAR30, PAR38, R40	639 – 847	40
	848 – 956	50
	957 – 1,183	55
	1,184 – 1,419	65
	1,420 – 1,789	75
	1,790 – 2,045	90
	2,046 – 2,578	100
	> 2,578	120
R14, PAR16, R16	200 – 299	30
	300 – 399	40
	400 – 499	50
	500 – 599	60
	600 – 1,000	65
MR16	< 450	35

Bulb Type	Lumen Range	$W_{b,ES}$
	450 – 600	50
	> 600	75
For any lamps/bulb types for reflector lamps not captured in the criteria above	All	Use ENERGY STAR Watts Equivalent

Peak Factors

Table 2-116 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.06	[158]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-117 Measure Life

Equipment	EUL	RUL	Ref
Lamps and Fixtures	15	5	[169][170]

References

[158] "MID-ATLANTIC TECHNICAL REFERENCE MANUAL VERSION 9." n.d. Accessed November 23, 2022. https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf .

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[161] *Southern California Edison Company, LED,Electroluminescent & Fluorescent Night Lights: Work Paper WPSCRELG0029 Rev.1,* (February 2009), pp. 2–3

[162] The DSMore Michigan Database of Energy Efficiency Measures: Based on spreadsheet calculations using collected data

[163] Typical values of lights per strand and strands per package at Home Depot and other stores

[164] "Regulations.gov." n.d. Www.regulations.gov. Accessed December 1, 2022. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022.

[165] "New Jersey A5160 | 2020-2021 | Regular Session." n.d. LegiScan. Accessed December 1, 2022. https://legiscan.com/NJ/bill/A5160/2020.

[166] https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#430.32

[167] Based on RECS 2015 data for Middle Atlantic Region (Table HC6.7).

[168] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 10. (New York State Joint Utilities, 2022), Pg 341-344, https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

[169] ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs) V2.1, June 2017, pg. 19 (Capped at 20 years). https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2.1%20Final%20Specification.pdf

[170] ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18 (Capped at 20 years). https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

2.4.2 OCCUPANCY SENSOR

Market	Residential/Multifamily
Baseline Condition	RF/DI/TOS
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure defines the savings associated with installing a wall-mounted occupancy sensor that switches lights off after a brief delay when it does not detect occupancy.

Baseline Case

The baseline case is lighting controlled by a manual switch.

Efficient Case

The efficient condition is lighting that is controlled with an occupancy sensor. It is assumed that the controlled load is a mix of efficient and inefficient lighting.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = (W_q/1{,}000) \times hrs \times SVG_e \times ISR \times (1 + HVAC_e)$$

Annual Fuel Savings

$$\Delta Therms = (W_q/1{,}000) \times hrs \times SVG_e \times ISR \times HVAC_g$$

Peak Demand Savings

$$\Delta kW_{Peak} = (W_q/1{,}000) \times SVG_e \times ISR \times CF \times (1 + HVAC_d)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-118 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
W_q	Total wattage of the fixture(s) being controlled by the occupancy sensor	Site specific, if unknown assume 105.5	W	[182]
SVG_e	Percentage of annual lighting energy saved by lighting control	Site-specific, if unknown assume 28%	%	[175]
ISR	In service rate or percentage of units rebated that get installed	Site-specific, if unknwon use default = 0.98	N/A	[176]
Hrs	Average hours of use per year	Look up in Table 2-119	Hours	[171][146] [172][173][174]
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 2-120	N/A	[174]
$HVAC_g$	HVAC Interactive Factor for Annual Fuel Savings	Look up in Table 2-120	N/A	[174]
$HVAC_d$	HVAC Interactive Factor for Peak Demand Savings	Look up in Table 2-120	N/A	[174]
1000	Unit Conversion, kW/Watts	1,000	kW/W	

Variable	Description	Value	Units	Ref
CF	Electric coincidence factor	Look up in Table 2-121	N/A	
PDF	Gas peak day factor	Look up in Table 2-121	N/A	
EUL	Effective useful life	See	Years	

Table 2-119 Hours

Installation Location	Annual Hours
Residential interior & in-unit Multi Family	679
Multi Family Common Areas	5,950
Unknown	679

Table 2-120 HVAC Interactive Factors, and Heating Factor

Installation Location	$HVAC_e$[36]	$HVAC_d$[37]	$HVAC_g$
Interior	0.023	0.155	-0.47
Exterior	0	0	0
Unknown	0.020	0.134	-0.41

Peak Factors

Table 2-121 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Lookup in Table 2-122	[178][179][180]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Table 2-122 Summer Electric Peak Coincidence Factors

Installation Location	Type	Coincidence Factor (CF)
Residential interior and in-unit Multi Family	Utility Peak CF	0.059
	PJM CF	0.058

[36] For electric cooling interactivity, value based on NEEP Mid-Atlantic TRM V9, p. 22: Calculated using defaults assuming 89% of homes have electric cooling (per RECS 2015 data) with an average 3.8 COP and a cooling load reduction of 33% of lighting savings; 0.89*(0.33 / 3.8) = 0.077.
For electric heating interactivity, value based on NEEP Mid-Atlantic TRM V9, p. 22: Calculated using defaults assuming 20% of homes are electrically heated (per RECS 2015 data) with an average 1.74 COP and a heating load increase of 47% of lighting savings; -0.20*(0.47 / 1.74) = -0.054. Value of $HVAC_e$ established as the summation of these values; 0.077 – 0.054 = 0.023.

[37] From NEEP Mid-Atlantic TRM V9, p. 24: Calculated using defaults assuming 89% of homes have electric cooling (per RECS 2015 data) with an average 3.8 COP and peak cooling load reduction of 66% of lighting savings; 0.89*(0.66 / 3.8) = 0.155.

Installation Location	Type	Coincidence Factor (CF)
Multi Family Common Areas	PJM CF	0.86
Exterior	PJM CF	0.018
Unknown	Utility Peak CF	0.059
	PJM CF	0.058

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-123 Measure Life

Equipment	EUL	RUL	Ref
Occupancy Sensor	15	5	[181]

References

[171] Based on Navigant Consulting, "EmPOWER Residential Lighting Program: 2016 Residential Lighting Inventory and Hours of Use Study" August 31, 2017, page 13. The HOU value is for an efficient lamp.

[172] Multi family common area lighting assumption is 16.3 hours per day (5950 hours per year) based on Focus on Energy Evaluation, ACES Deemed Savings Desk Review, November 2010. This estimate is consistent with the Common Area "Non-Area Specific) assumption (16.2 hours per day or 5913 annually) from the Cadmus Group In., "Massachusetts Multifamily Program Impact Analysis", July 2012, p 2-4.

[173] Unknown" assumes a residential interior or in-unit multifamily application.

[174] "MID-ATLANTIC TECHNICAL REFERENCE MANUAL VERSION 9." n.d. Accessed November 23, 2022. https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf. https://neep.org/sites/default/files/resources/NEEP_CI_Lighting_LS_FINAL_Report_ver_5_7-19-11_0.pdf

[175] Average of two studies. Navigant Consulting. Department of Energy Solid-State Lighting Program. Energy Savings Estimates of Solid-State Lighting in General Illumination Lighting Applications. September 2016. This study estimates a 29% energy savings from connected lighting in residential applications. (Table F.4). Efficiency Vermont. Smart Lighting & Smart Hub. DIY Install: Does it Yield. August 2016. This study estimates reductions in hours of use of up to 27%. Additionally, the metering study saw significant amounts of dimming of lamps that were on non-dimming circuits, but did not quantify the savings associated with this consumer action.

[176] First year ISR of 0.9 (EMPOWER MD Lighting Study, EY5). Assume lifetime ISR of 0.99 (2006-2008 California Residential Lighting Evaluations, and used in the Uniform Methods Project). Assume half of bulbs not installed in year one are installed in year two, and the other half in year three. Using a discount rate of 5%, this gives 0.90 + 0.045 * 0.95 + 0.045 * 0.95^2 = 0.98

[177] The criteria that are used to determine whether equipment is "operational" vary among jurisdictions and there is no related industry standard practice. This TRM provides assumptions for estimating savings and costs for early replacement measures, but does not address this threshold question of whether a measure should be considered early replacement.

[178] Based on Navigant Consulting "EmPOWER Residential Lighting Program: 2016 Residential Lighting Inventory and Hours of Use Study" August 31, 2017, page 15

[179] Consistent with value currently used for EmPOWER Maryland Programs as of October 1, 2017. Derived from C&I common area lighting coincidence.

[180] Calculated from Itron eShapes, which is 8760 hourly data by end use for Upstate New York.

[181] Navigant, *ComEd Luminaire Level Lighting Control IPA Program Impact Evaluation Report* Table 8.1 Page 10 https://icc.illinois.gov/docket/P2020-0486/documents/299941/files/523013.pdf.

[182] Statewide Evaluation Team (GDS Associates Inc, Nexant, Research Into Action, Apex Analytics LLC), *Energy Efficiency Potential Study for Pennsylvania* (2015), Appendix D, Pg D-1, https://www.puc.pa.gov/pcdocs/1345079.pdf

2.5 PLUG LOAD

2.5.1 OFFICE EQUIPMENT

Market	Residential/Multifamily
Baseline Condition	TOS
Baseline	Code
End Use	Plug Load
Measure Last Reviewed	December 2022

Description

This section provides deemed savings for installing ENERGY STAR office equipment compared to standard efficiency equipment in residential and multifamily applications.

Per unit savings are primarily derived from the ENERGY STAR calculator for office equipment [183].

Baseline Case

The baseline condition is assumed to be standard equipment of similar type used in a residential setting.

Efficient Case

The efficient condition is ENERGY STAR equipment meeting ENERGY STAR v8 Eligibility Criteria [184] and used in a residential setting.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = Lookup\ in\ \text{Table 2-125}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = Lookup\ in\ \text{Table 2-125}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 2-124 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Lookup in Table 2-125	kWh/yr	[183]
ΔkW_{Peak}	Peak Demand Savings	Lookup in Table 2-125	kW	[183]
ΔkW_{Life}	Lifetime electric energy savings	Calculated	kWh	

Table 2-125 Office Equipment Energy and Demand Savings Values per Unit

Measure		Energy Savings (kWh)	Demand Savings (kW)	Source
Computer (Desktop)		119	0.0161	[183]
Computer (Laptop)		22	0.0030	[183]
Printer (laser, monochrome)	≤ 5 images/min	37	0.0050	[183]
Printer (laser, monochrome)	5 < images/min ≤ 15	26	0.0035	[183]
Printer (laser, monochrome)	15 < images/min ≤ 20	24	0.0031	[183]
Printer (laser, monochrome)	20 < images/min ≤ 30	42	0.0057	[183]
Printer (laser, monochrome)	30 < images/min ≤ 40	50	0.0068	[183]
Printer (laser, monochrome)	40 < images/min ≤ 65	181	0.0244	[183]
Printer (laser, monochrome)	65 < images/min ≤ 82	372	0.0502	[183]
Printer (laser, monochrome)	82 < images/min ≤ 90	542	0.0732	[183]
Printer (laser, monochrome)	> 90 images/min	686	0.0926	[183]
Printer (Ink Jet)		6	0.0008	[183]
Multifunction Device (laser, monochrome)	≤ 5 images/min	57	0.0077	[183]
Multifunction Device (laser, monochrome)	5 < images/min ≤ 10	48	0.0065	[183]
Multifunction Device (laser, monochrome)	10 < images/min ≤ 26	52	0.0070	[183]
Multifunction Device (laser, monochrome)	26 < images/min ≤ 30	93	0.0126	[183]
Multifunction Device (laser, monochrome)	30 < images/min ≤ 50	248	0.0335	[183]

Measure		Energy Savings (kWh)	Demand Savings (kW)	Source
	50 < images/min ≤ 68	420	0.0567	
	68 < images/min ≤ 80	597	0.0806	
	> 80 images/min	764	0.1031	
Multifunction Device (Ink Jet)		6	0.0008	[183]
Monitor		8	0.0032	[183]

Peak Factors

Peak savings are incorporated in the demand savings values above.

Measure Life

The measure life for residential office equipment is 5 years [185].

References

[183] ENERGY STAR Office Equipment Calculator https://dnr.mo.gov/sites/dnr/files/media/file/2021/01/office-equipment-calculator.xlsx. Per PA TRM: "Using a commercial office equipment load shape, the percentage of total savings that occur during the PJM peak demand period was calculated and multiplied by the energy savings. As of December 1, 2018, the published ENERGY STAR Office Equipment Calculator does not reflect the current specification for computers (ENERGY STAR® Program Requirements Product Specification for Computers Eligibility Criteria Version 8.0). As a result, the savings values for computers presented in this measure entry reflect savings for V6-compliant models. This characterization should be updated when an updated ENERGY STAR Office Equipment Calculator becomes available."

[184] ENERGY STAR Computers Final Version 8.0 Specification Rev. July 2022

[185] Residential desktop measure life. California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/027/

2.5.2 TELEVISIONS

Market	Residential/multifamily
Baseline Type	TOS
Baseline	Code
End Use Subcategory	Electronics
Measure Last Reviewed	December 2022

Description

This measure relates to the upstream promotion of televisions meeting the ENERGY STAR "Most Efficient Television" Eligibility Criteria.

Baseline Case

The baseline condition is assumed to be a television meeting the Energy Star 8.0 efficiency standard and used in a residential setting.

Efficient Case

The efficient condition is an ENERGY STAR television meeting the EPA Most Efficient TV criteria and used in a residential setting.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = (kW_b - kW_q) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \mathrm{N/A}$$

Calculation Parameters

Table 2-126 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kWh_b	Annual electric energy savings for baseline case	Look up in Table 2-127	kWh/yr	[186][187]
kWh_q	Peak Demand Savings for efficient case	Look up in Table 2-127	kWh/yr	[186][188]
kW_b	Peak Demand Savings for baseline case	Look up in Table 2-128	kW	[186][187]
kW_q	Annual electric energy savings for efficient case	Look up in Table 2-128	kW	[186][188]
CF	Coincidence factor	Look up in Table 2-129	N/A	
PDF	Gas peak demand factor	Look up in Table 2-129	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	

Table 2-127 Conventional and ENERGY STAR kWh

Diagonal screen size	Conventional kWhb	ENERGY STAR kWhq
20	35.3	30.9
22	37.8	32.6
26	44.5	37.2
32	54.1	44.0
37	64.1	51.1
42	75.2	59.0
47	86.9	67.6
52	98.9	76.7
57	110.7	85.9

Diagonal screen size	Conventional kWhb	ENERGY STAR kWhq
62	121.9	95.1
65	128.2	100.4

Table 2-128 Conventional and ENERGY STAR kW

Diagonal screen size	Conventional kWb	ENERGY STAR kWq
20	0.018	0.016
22	0.020	0.017
26	0.024	0.020
32	0.029	0.023
37	0.034	0.027
42	0.040	0.032
47	0.047	0.036
52	0.053	0.041
57	0.060	0.046
62	0.066	0.051
65	0.069	0.054

Peak Factors

Table 2-129 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)[38]	0.21	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The estimated useful life (EUL) is 6 years. [186]

References

[186] "Consumer_Electronics_Calculator". October 2016. Energystar.gov. Accessed December 9, 2022. https://www.energystar.gov/sites/default/uploads/buildings/old/files/Consumer_Electronics_Calculator.xlsx.

[187] ENERGY STAR® Program Requirements for Televisions Eligibility Criteria Version 8.0 https://www.energystar.gov/sites/default/files/Final%20V8.0%20TVs%20Program%20Requirements.pdf

[38] The coincidence value is an estimate based on the on-mode hours per day (5 hours/day) as a percentage of all hours.

[188] ENERGY STAR® Most Efficient 2020 Recognition Criteria Televsions https://www.energystar.gov/sites/default/files/Televisions%20ENERGY%20STAR%20Most%20Efficient%202020%20Final%20Criteria.pdf

2.5.3 SMART STRIP

Market	Residential/Multifamily
Baseline Condition	RF/DI/TOS
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	December 2022

Description

Advanced Power Strips (APS) are surge protectors that contain a number of power-saver sockets. There are two types of APS: Tier 1 and Tier 2.

Tier 1 APS have a master control socket arrangement and will shut off the items plugged into the controlled power-saver sockets when they sense that the appliance plugged into the master socket has been turned off. Conversely, the appliance plugged into the master control socket has to be turned on and left on for the devices plugged into the power-saver sockets to function.

Tier 2 APS deliver additional functionality beyond that of a Tier 1 unit, as Tier 2 units manage both standby and active power consumption. The Tier 2 APS manage standby power consumption by turning off devices from a control event; this could be a TV or other item powering off, which then powers off the controlled outlets to save energy. Active power consumption is managed by the Tier 2 unit by monitoring a user's engagement or presence in a room by either or both infrared remote signals sensing or motion sensing. After a period of user absence or inactivity, The Tier 2 unit will shut off all items plugged into the controlled outlets, thus saving energy. There are two types of Tier 2 APS available on the market. Tier 2 Infrared (IR) detect signals sent by remote controls to identify activity, while Tier 2 Infrared-Occupancy Sensing (IR-OS) use remote signals as well as an occupancy sensing component to detect activity and sense for times to shut down. Due to uncertainty surrounding the differences in savings for each technology, the Tier 2 savings are blended into a single number.

Baseline Case

The assumed baseline is a standard power strip that does not control any of the connected loads.

Efficient Case

The efficient case is the use of a Tier 1 or Tier 2 Advanced Power Strip.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = Usage \times ERP \times ISR$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = Load \times ERP_{Peak} \times ISR$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-130 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	N/A	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	N/A	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Usage	Annual usage of system connected to power strip	Lookup in Table 2-131	kWh	[189]
ERP	Energy reduction percentage	Lookup in Table 2-131	N/A	[189]

Variable	Description	Value	Units	Ref
ISR	In-service rate	Look up by program in Appendix J: In-Service Rates, or use default values in Table 2-131	N/A	[189]
Load	Demand of system connected to power strip	Lookup in Table 2-131	kW	[189]
ERP_{Peak}	Energy reduction percentage during peak period	Lookup in Table 2-131	N/A	[189]
CF	Electric coincidence factor	Look up in Table 2-132	N/A	
PDF	Gas peak demand factor	Look up in Table 2-132	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-131 Impact Factors for Advanced Power Strip Types

Strip Type	End-Use	ERP	ERP_{Peak}	ISR	Usage (kWh)	Load (kW)
Tier 1	Home Entertainment Center	0.27	0.20	0.86	471	0.057
Tier 1	Home Office	0.21	0.18	0.86	399	0.043
Tier 1	Unspecified	0.25	0.19	0.81	449	0.051
Tier 2	Unspecified	0.44	0.41	0.76	471	0.058

Peak Factors

Peak demand savings are accounted for in the percent reduction factors presented above.

Table 2-132 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-133 Measure Life

Equipment	EUL	RUL	Ref
Smart Strip	5	1.67	[190]

References

[189] RLPNC 17-3: Advanced Power Strip Metering Study," Massachusetts Programs Administrators and EEAC, (Mar. 2019), https://ma-eeac.org/wp-content/uploads/RLPNC_173_APSMeteringReport_Revised_18March2019.pdf

[190] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx. Accessed December 2018.

2.5.4 SOUNDBAR

Market	Residential/Multifamily
Baseline Type	TOS
Baseline	Code
End Use Subcategory	Soundbar
Measure Last Reviewed	December 2022

Description

This measure covers soundbars in residential applications meeting the minimum qualifying efficiency standards established under the ENERGY STAR® program, Program Requirements for Audio/Video Version 3.0, effective December 2014. A soundbar is a mains-connected product that offers audio amplification housed in a wide horizontal enclosure. ENERGY STAR® rated soundbars have a lower power draw when in sleep and idle modes and a higher amplifier efficiency than conventional models. Qualified soundbars use about 70% less energy than unqualified equipment.

Baseline Case

The baseline condition is a non-ENERGY STAR® qualified soundbar in a residential application.

Efficient Case

The compliance condition is an ENERGY STAR® qualified soundbar in a residential application with power performance specifications meeting or exceeding the requirements of ENERGY STAR® Program Requirements for Audio/Video Version 3.0, effective December 2014.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = units \times (kWh_b - kWh_q)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{8{,}760} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 2-134 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Units	Number of measures installed during program	Site-specific	N/A	
kWh_b	Energy consumption for baseline case	77	kWh/yr	[191]
kWh_q	Efficient unit energy consumption	29	kWh/yr	[191]
8,760	Hours in 1 year	8,760	Hours/yr	
CF	Electric coincidence factor	Look up in Table 2-135	N/A	[193]
PDF	Gas peak demand factor	Look up in Table 2-135	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[194]

Peak Factors

Table 2-135 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[193]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 7 years. [194]

References

[191] Pacific Gas and Electric Work Paper PGECOAPP128 Retail Products Platform Revision #2, October 2015, pg 74 http://deeresources.net/workpapers

[192] Retail Products Platform: Product Analysis, Last updated May 25, 2016 – ENERGY STAR® + 15% annual consumption increased by 15% to reflect minimum compliance with ENERGY STAR® Specification V3.0

[193] Per NY TRM: "No source specified – update pending availability and review of applicable references."

[194] EPA, Consumer Messaging Guide for Energy Star Certified Consumer Electronics. December 2016. https://www.energystar.gov/sites/default/files/asset/document/CE_Consumer_Messaging.pdf

2.5.5 ELECTRIC VEHICLE CHARGERS

Market	Residential/Multifamily
Baseline Condition	TOS
Baseline	ISP
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

The measure is for the purchase of a Level 2 electric vehicle charger consistent with the ENERGY STAR V1.1 specification for Electric Vehicle Supply Equipment (EVSE) installed for residential household use. Networked chargers enable access to online energy management tools through an EVSE network. Non-networked chargers are standalone units that are not connected to other units through an EVSE network.

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified.

Baseline Case

A non-ENERGY STAR V1.1 networked or non-networked Level 2 electric vehicle charger.

Efficient Case

An ENERGY STAR qualified networked or non-networked Level 2 electric vehicle charger [195].

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = ((Hrs_{PS} + Hrs_{US}) \times W_b - (Hrs_{PS} \times W_{q,p} + Hrs_{US} \times W_{q,u}))/1,000$$

Where,

$$Hrs_{ps} = Hours_p - Hours_c$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = Avg_{kW} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-136 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Hrs_{ps}	Annual standby hours plugged in	Calculated	Hours	
Hrs_{c}	Annual active charging hours	Site-specific, if unknown assume 278	Hours	[199]
Hrs_{p}	Total annual hours plugged in	Site-specific, if unknown assume 3,511	Hours	[199]
Hrs_{us}	Annual standby hours unplugged	Site-specific, if unknown assume 5,249	Hours	[199]
W_{b}	Baslines average standby power	Lookup in Table 2-137	W	[196][197]
$W_{q,p}$	Efficient average standby power with vehicle plugged in	Lookup in Table 2-137	W	[198]
$W_{q,u}$	Efficient average standby power in no vehicle mode	Lookup in Table 2-137	W	[198]
Avg_{kW}	Average electric demand during standby	Lookup in Table 2-137	kW	
CF	Electric coincidence factor	Lookup in Table 2-138	N/A	
PDF	Gas peak day factor	Lookup in Table 2-138	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-137 Standby Power

Network Type	W_b	$W_{q,p}$	$W_{q,u}$	kW
Non-Networked[39]	3.7	3.5	2.1	0.00107
Networked[39]	9.9	3.2	2.5	0.00713

Peak Factors

Table 2-138 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years [195].

References

[195] Energy Star Spec v1.1 effective from 3/31/2021. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20V1.1%20DC%20EVSE%20Final%20Specification_0.pdf

[196] Based on Northwest Power and Conservation Council, Regional Technical Forum updated workbook for Level 2 Electric Vehicle Charger version 3.0 https://nwcouncil.app.box.com/v/Lvl2EVChrgrsv3-0

[197] INL charger testing https://avt.inl.gov/evse-type/ac-level-2.html

[198] "ENERGY STAR Market and Industry Scoping Report: Electric Vehicle Supply Equipment ENERGY STAR Market and Industry Scoping Report Electric Vehicle Supply Equipment (EVSE)" 2013 (source data is from INL). https://www.energystar.gov/sites/default/files/asset/document/electric_vehicle_scoping_report.pdf

[199] 2021 ENERGY STAR QPL of Residential EVSE. Averaged Partial On Mode Input Power (W) and Idle Mode Input Power (W). See Northwest Power and Conservation Council, Regional Technical Forum updated workbook for Level 2 Electric Vehicle Charger version 3.0 https://nwcouncil.app.box.com/v/Lvl2EVChrgrsv3-0

[39] kW for non-networked and networked type = $(((W_b - W_{q,p}) * Hrs_{PS}/8482) + ((W_b - W_{q,u}) * Hrs_{US}/8482))/1000$

2.6 SHELL

2.6.1 RESIDENTIAL/LOW-RISE MULTIFAMILY AIR SEALING

Market	Residential/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Shell
Measure Last Reviewed	January 2023

Description

This section provides energy savings algorithms for the sealing air leakage paths to reduce the natural air infiltration rate through the installation of products and repairs to the building envelope. It is assumed that air sealing is the first priority among candidate space conditioning measures. Expected percentage savings is based on previous experiences with measured savings from similar programs.

Methods are provided below for single-family, low-rise multifamily and high-rise multifamily applications with and without blower door testing conducted before and after implementation of air sealing treatments. A blower door test is performed to measure the leakage rate by depressurizing the building to a standard pressure difference of 50 Pascals or 0.2 inches of water.

Blower door tests shall be performed whenever possible. This method provided below for single family/low-rise multifamily without blower door testing should only be used if blower door testing is not feasible due to health or safety concerns, e.g. the presence of a hazardous material like asbestos or mold, ongoing construction in the home or concerns regarding COVID-19.

Baseline Case

The baseline case is a building envelope with natural air infiltration through air leakage paths.

Efficient Case

The exterior envelope, as well as interior walls/partitions between conditioned and unconditioned spaces should be inspected and all gaps sealed. At a minimum, the following items shall be inspected, and sealing measures may be implemented based upon inspection results:

- Caulk and weather strip doors and windows that leak air
- Repair or replace doors leading from conditioned to unconditioned space
- Seal air leaks between unconditioned (including unconditioned basement and attics) and conditioned spaces to include, but not limited to, plumbing, ducting, electrical wiring, wall top plates, chimneys, flues, and dropped soffits

- Use foam sealant on larger gaps around windows, baseboards, and other places where air leakage, either infiltration or exfiltration may occur

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{\Delta CFM_{50}}{F_n \times F_h}\right) \times \left(\frac{\Delta kWh}{CFM}\right)$$

Annual Fuel Savings

$$\Delta Therms = \left(\frac{\Delta CFM_{50}}{F_n \times F_h}\right) \times \left(\frac{\Delta therms}{CFM}\right)$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{\Delta CFM_{50}}{F_n \times F_h}\right) \times \left(\frac{\Delta kW}{CFM}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-139 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	

Variable	Description	Value	Units	Ref
ΔCFM_{50}	Reduction in air leakage from blower door tests at 50 Pascals pressure difference	Site-specific, if unknown ΔCFM_{50}=0.50xSF[40]	CFM	
F_n	Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, climate zone factor	19	N/A	[200]
F_h	Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, building height factor	Look up in Table 2-140	N/A	[200]
ΔkWh/CFM	Annual electric energy savings per cubic foot per minute of reduced air leakage at 50 Pa	Look up in Table 2-141 or Table 2-142	kWh/CFM	[201]
ΔkW/CFM	Peak coincident demand electric savings per cubic foot per minute of reduced air leakage at 50 Pa	Look up in Table 2-141 or Table 2-142	kW/CFM	[201]
Δtherms/CFM	Annual fossil fuel energy savings per cubic foot per minute of reduced air leakage at 50 Pa	Look up in Table 2-141 or Table 2-142	therms/CFM	[201]
CF	Coincidence factor	Look up in Table 2-143	N/A	
PDF	Gas peak day factor	Look up in Table 2-143	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-140 Infiltration-Leakage Ratio, building height factor

Number of conditioned stories	F_h
1 story	1.00
1.5 stories	0.90
2 stories	0.81
2.5 stories	0.76
3 + stories	0.70

Table 2-141 Impact per CFM for Single-family Residential Infiltration Reduction

	ΔkWh/CFM	ΔkW/CFM	Δtherms/CFM
AC Fuel Heat	2.3	0.004	1.7
Heat Pump	21.0	0.003	N/A
AC Electric Heat	39.8	0.004	N/A

[40] For single-family and low-rise multifamily homes, if conducting a blower door test is not feasible due to health and safety concerns, multiply affected area square footage by a deemed ΔCFM_{50}/SF of 0.50 (i.e., ΔCFM_{50} = 0.50 x SF). Default ΔCFM_{50}/SF of 0.50 is the median value of single-family blower door test data provided by ConEdison, conducted 2018-2020.

	ΔkWh/CFM	ΔkW/CFM	Δtherms/CFM
Fuel Heat Only	0.8	0.000	1.7
Electric heat Only	38.4	0.000	N/A

Table 2-142 Impact per CFM for Multifamily Low-rise Infiltration Reduction

	ΔkWh/CFM	ΔkW/CFM	Δtherms/CFM
AC Fuel Heat	1.5	0.003	1.9
Heat Pump	21.2	0.003	N/A
AC Electric Heat	29.6	0.003	N/A
Fuel Heat Only	1.1	0.000	1.9
Electric heat Only	29.2	0.000	N/A

Peak Factors

Table 2-143 Peak Factors

Peak Factor	Value	Ref
Coincidence factor	0.69	[202]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 15 years [203].

References

[200] Lawrence Berkeley Laboratory, Estimation of Infiltration from Leakage and Climate Indicators, Sherman, M., December 1986, http://eta-publications.lbl.gov/sites/default/files/estimation_of_inflitration_from_leakage_and_climate_indicators.pdf

[201] New York State Joint Utilities, New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, V10, January 2023, Appendix E, Pg 1221. NYC values were used due to proximity to NJ.

[202] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011 and supported by research conducted by Cadmus on behalf of the RM Management Committee.

[203] GDS Associates, Inc. Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures. 2007. https://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf

2.6.2 INSULATION

Market	Residential/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Shell
Measure Last Reviewed	January 2023

Description

This measure applies to the installation of insulation to the attic floor, roof assembly, walls, and floors to reduce the thermal conductance of the building envelope. Energy and demand savings are realized through reductions in the building's heating and cooling loads. Existing (baseline) and installed (qualifying) shell R-values must be captured to estimate energy savings.

This measure is only applicable as a retrofit in existing single and multifamily buildings, excluding gut rehab/major renovation projects. These projects entail whole-building envelope alterations that trigger more stringent code provisions, limiting potential incremental savings.

For applications involving insulation on more than one component, evaluate each component separately via the method below and sum together to determine total estimated energy savings. If the age of the baseline equipment cannot be determined, assume two-third of the EUL has lapsed.

Baseline Case

The existing condition is a residential building envelope with insufficient insulation.

Efficient Case

The efficient condition is a residential building envelope with increased insulation meeting or exceeding applicable construction code requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

Savings from reduction in Air Conditioning Load:

$$\Delta kWh_{cooling} = \frac{\left(\frac{1}{R_b} - \frac{1}{R_q}\right) \times CDD \times 24 \times Area \times (1 - F_{framing})}{1{,}000 \times SEER}$$

Savings for homes with electric heat (Heat Pump or resistance):

$$\Delta kWh_{heating} = \frac{\left(\frac{1}{R_b} - \frac{1}{R_q}\right) \times HDD \times 24 \times Area \times (1 - F_{framing})}{1{,}000 \times HSPF}$$

Annual Fuel Savings

$$\Delta Therms = \frac{\left(\frac{1}{R_b} - \frac{1}{R_q}\right) \times HDD \times 24 \times Area \times (1 - F_{framing})}{Fuel\ Btu \times AFUE}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\left(\frac{1}{R_b} - \frac{1}{R_q}\right) \times Area \times (1 - F_{framing})}{1{,}000 \times EER} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-144 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta kWh_{cooling}$	Annual electric cooling energy savings	Calculated	kWh/yr	
$\Delta kWh_{heating}$	Annual electric heating energy savings	Calculated	kWh/yr	
R_b	R-value of existing insulation	Site-specific, if unknown look up in Table 2-146	h.ft^2.°F/Btu	
R_q	R-value of new insulation	Site-specific	h.ft^2.°F/Btu	

Variable	Description	Value	Units	Ref
CDD	Cooling degree days: number of degrees the average daily temperature is above 65°F	Loo kup in Table 2-147	°F-day/yr	[204]
Area	Area of insulated surface	Site-specific	ft^2	
$F_{framing}$	Framing factor	Look up in Table 2-145	N/A	[206]
1,000	Conversion Factor from W to kW	N/A	W/kW	
SEER/SEER2	Efficiency in SEER of Air Conditioning equipment	Site specific, if unknown look up in Table 2-148	Btu/watt-hr	[207]
EER/EER2	Efficiency in EER of Air Conditioning equipment	Site-specific. If unknown, see Appendix E: Code-Compliant Efficiencies	Btu/watt-hr	[207]
HDD	Heating degree days: number of degrees the average daily temperature is below 65°F	Look up in Table 2-147	°F-day/yr	[204]
HSPF/HSPF2	Heating Seasonal Performance Factor	Site specific, if unknown look up in Table 2-149	Btu/watt-hr	[207]
Fuel Btu	Conversion Factor to Therms	Look up in Table 2-152		
AFUE	Annual Fuel Utilization Efficiency – Boilers & Furnaces	Site-specific, if unknown look up in Table 2-150, Table 2-151	N/A	[207]
AFUE	Annual Fuel Utilization Efficiency – Electric Resistance Heating	35%	N/A	[208]
CF	Electric coincidence factor	Look up in Table 2-153	N/A	
PDF	Gas peak day factor	Look up in Table 2-153	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-145 Framing Factor

Insulation Location	Value	Ref
Framing factor - Ceiling	7%	[206]
Framing factor - Wall	25%	[206]
Framing factor - Floor	12%	[206]

Table 2-146 Existing Insulation R-Value (R_b)

Building Envelope Component	Value
Fiberglass - Batt	3.14
Fiberglass – Blown Attic	2.2

Building Envelope Component	Value
Fiberglass – Blown Wall	3.2
Rock Wool - Batt	3.14
Rock Wool – Blown Attic	3.1
Rock Wool – Blown Wall	3.03
Cellulose – Blown Attic	3.13
Cellulose – Blown Wall	3.7
Vermiculite	2.13
Air-entrained Concrete	3.9
Urea Terpolymer Foam	4.48
Rigid Fiberglass (> 4 lb/ft^3)	4
Expanded Polystyrene (Beadboard)	4
Extruded Polystyrene	5
Polyurethane (Foamed-in-place)	6.25
Polyisocynaurate (Foil-face)	7.2

Table 2-147 Heating and Cooling Degree Days (65°F set point)

City	HDD	CDD
North	5,734	778
Coastal	4,614	1,056
Central	5,051	1,073
Pine barrens	4,891	1,067
Southwest	5,028	1,046
Statewide Average	5,077	1,017

Table 2-148 Cooling Equipment SEER

Cooling Equipment	SEER	SEER2
Split System (A/C)	13	13.4
Split System (HP)	14	14.3
Single Package (A/C)	14	13.4
Single Package (HP)	14	13.4

Table 2-149 Cooling Equipment HSPF

Cooling Equipment	HSPF	HSPF2
Split System (HP)	8.2	7.5
Single Package (HP)	8.0	6.7

Table 2-150 AFUE of Residential Boilers

Product Class	AFUE (Manufactured before Sep 1, 2012)	AFUE (Manufactured on and after Sep 1, 2012 and before Jan 15, 2021)	AFUE (Manufactured on and after January 15, 2021)
Gas-fired hot water boiler	0.80	0.82	0.84
Gas-fired steam boiler	0.75	0.80	0.82
Oil-fired hot water boiler	0.80	0.84	0.86
Oil-fired steam boiler	0.80	0.82	0.85

Table 2-151 AFUE of Residential Furnaces

Product Class	AFUE	Compliance Date	AFUE (Manufactured before compliance Date)
Non-weatherized gas furnaces (not including mobile home furnaces)	0.80	November 19, 2015.	0.78
Mobile Home gas furnaces	0.80	November 19, 2015.	0.75
Non-weatherized oil-fired furnaces (not including mobile home furnaces)	0.83	May 1, 2013.	0.78
Mobile Home oil-fired furnaces	0.75	September 1, 1990.	0.75
Weatherized gas furnaces	0.81	January 1, 2015.	0.78
Weatherized oil-fired furnaces	0.78	January 1, 1992.	0.78

Table 2-152 BTU Conversion Factors

Conversion Factor	Value	Units
Natural Gas - BTU to Therms	100,000	Btu/Therms
Heating Oil - BTU to Gallons to Therms	138,000 x 0.916	Btu/Therms
Propane - BTU to Gallons Therms	92,000 x 1.4	Btu/Therms

Peak Factors

Table 2-153 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[205]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 25 years [209].

References

[204] ONJSC: Monthly/Annual Temperature Normals (1991-2020). http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html.

[205] BG&E: Development of Residential Load Profile for Central Air Conditioners and Heat Pumps, as reported in NEEP, Mid-Atlantic Technical Reference Manual, V8. 2018, p. 260

[206] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1.

[207] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430 eCFR. December 1, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[208] Electric resistance heating calculated by determining overall fuel cycle efficiency by dividing the average PJM heat rate (9,642 btu/kWh) by the btu's per kWh (3,413 btu/kWh), resulting in 2.83 btuin per 1 btuout.

[209] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures.

2.7 WATER HEATING

2.7.1 HEAT PUMP WATER HEATER

Market	Residential/Multifamily
Baseline Condition	NC/TOS/DI/EREP
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

Heat pump water heaters take heat from the surrounding air and transfer it to the water in the tank, unlike conventional water heaters, which use either gas (or sometimes other fuel) burners or electric resistance heating coils to heat the water.Due to the interactivity of the heat pump water heater with the building's HVAC system, there is a decrease in a home's cooling energy consumption and an increase in the heating energy consumption if the heat pump water heater is located in conditioned space.

Baseline Case

TOS/NC baseline equipment is a minimally code compliant, electric storage type water heater.[41] EREP/DI baseline equipment is a minimally code compliant system of the same type and fuel as the existing equipment.

Efficient Case

The efficient condition is an ENERGY STAR V. 5.0 qualified heat pump water heater.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{dhw} + \Delta kWh_{cooling} - \Delta kWh_{heating}$$

Where,

$$\Delta kWh_{dhw} = \frac{Load_{dhw}}{3{,}412} \times \left(\frac{F_{dhw,electric}}{UEF_b} - \frac{1}{UEF_q \times F_{derate}}\right)$$

$$\Delta kWh_{cooling} = \frac{Load_{dhw}}{1{,}000} \times \left(1 - \frac{1}{UEF_q}\right) \times F_{location} \times \frac{F_{cool}}{SEER}$$

[41] Note that heat pump water heaters are code required for tanks greater than 55 gallons.

$$\Delta kWh_{heating} = \frac{Load_{dhw}}{1{,}000} \times \left(1 - \frac{1}{UEF_q}\right) \times F_{location} \times F_{heat,electric} \times \frac{F_{heat}}{HSPF}$$

$$Load_{dhw} = GPD \times 365 \times 8.33 \times (T_{set} - T_{main})$$

$$GPD = 17.2 \times N_{ppl}$$

Annual Fuel Savings

$$\Delta Therms = \Delta Therms_{dhw} - \Delta Therms_{heating}$$

Where,

$$\Delta Therms_{dhw} = \frac{Load_{dhw}}{100000} \times \left(\frac{F_{dhw,ff}}{UEF_b} + \frac{F_{dhw,boiler}}{AFUE}\right)$$

$$\Delta Therms_{heating} = \frac{Load_{dhw}}{100000} \times \left(1 - \frac{1}{UEF_q}\right) \times F_{location} \times F_{heat,ff} \times \frac{F_{heat}}{AFUE}$$

Peak Demand Savings[42]

For water heaters with a rated storage volume of 55 gallons or less:

$$\Delta kW_{Peak} = 0.09 \times \frac{UEF_q}{3.41}$$

For water heaters with a rated storage volume greater than 55 gallons:

$$\Delta kW_{Peak} = 0.11 \times \frac{UEF_q}{3.34}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

[42] Constants in peak demand equations from Mid-Atlantic TRM v10: "Analysis of special study. Cadmus, "EmPOWER Maryland Heat Pump Water Heater Baseline and Market Analysis", February 2020. The study leveraged HPWH load shapes from "Field Testing of Pre-Production Prototype Residential Heat Pump Water Heaters" (https://www.energy.gov/sites/prod/files/2014/01/f7/heat_pump_water_heater_testing.pdf)."

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-154 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{dhw}	Annual domestic hot water electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{cooling}$	Annual cooling electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{heating}$	Annual heating electric energy impacts	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{dhw}$	Annual domestic hot water fuel savings	Calculated	Therms/yr	
$\Delta Therms_{heat}$	Annual space heating fuel impacts	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Load_{dhw}$	Annual hot water load	Calculated	Btu	
v_t	Tank volume	Site-specific	Gal	
UEF_q	Uniform energy factor of efficient unit	Site-specific, if unknown look up in Table 2-157	N/A	[216]
AFUE	Annual fuel utilization efficiency of existing space heating or domestic hot water boiler or furnace	Site-specific, if unknown look up in Table 2-160	N/A	[213]
GPD	Gallons per day	Calculated, if N_{ppl} unknown use 46	Gal/day	[210]
N_{ppl}	Number of people in the home	Site-specific, if unknown use default 2.65	persons	[219]
$F_{DHW,electric}$	Electric water heating factor	Look up in Table 2-155	N/A	
$F_{DHW,g}$	Gas water heating factor	Look up in Table 2-155	N/A	
$F_{DHW,boiler}$	Gas boiler water heating factor	Look up in Table 2-155	N/A	
$F_{heat,electric}$	Electric space heating factor	Look up in Table 2-155	N/A	

Variable	Description	Value	Units	Ref
$F_{heat,g}$	Gas space heating factor	Look up in Table 2-155	N/A	
UEF_b	Uniform energy factor of baseline unit as a function of baseline fuel type.	Look up in Table 2-156	N/A	[213][214]
F_{derate}	Efficiency derating factor	Look up in Table 2-158	N/A	[215][216]
$F_{location}$	Installation location factor	Look up in Table 2-158	N/A	
SEER	Seasonal energy efficiency ratio of existing air conditioning system	Look up in Table 2-159	Btu/W·hr	
HSPF	Heating seasonal performance factor of existing electric heating system	Look up in Table 2-159	Btu/W·hr	
CF	Electric coincidence factor	Look up in Table 2-161	N/A	
PDF	Gas peak day factor	Look up in Table 2-161	N/A	
T_{set}	Water heater setpoint temperature	125	°F	[211]
T_{main}	Supply water temperature in water main	60	°F	[212]
F_{cool}	Cooling factor	0.51	N/A	[214]
F_{heat}	Heating factor	0.49	N/A	[214]
365	Days per year	365	Days/yr	
8.33	Unit conversion, Btu/gal·°F	8.33	Btu/gal·°F	
3,412	Unit conversion, Btu/kWh	3,412	Btu/kWh	
3.412	Unit conversion, Btu/W·hr	3.412	Btu/W·hr	
1000	Unit conversion, Watt/kW	1000	W/kW	
100,000	Unit conversion, Btu/therm	100,000	Btu/therm	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-155 DHW and Heating Factors

Baseline Scenario	$F_{DHW,electric}$	$F_{DHW,g}$	$F_{DHW,boiler}$	$F_{heat,electric}$	$F_{heat,g}$
TOS/NC: use electric baseline	1.0	0	0	1.0	0
EREP/DI with existing electric water heater and space heat	1.0	0	0	1.0	0
EREP/DI with existing gas water heater and space heat	0	1.0	1.0	0	1.0

Table 2-156 Baseline UEF

Product Class	Rated Storage Volume and Input Rating	First Hour Rating	UEF_b
Electric Storage Water Heater	≥ 20 gal and ≤ 55 gal	< 18 gallons	$0.8808 - (0.0008 \times v_t)$
		≥ 18 and < 51 gallons	$0.9254 - (0.0003 \times v_t)$
		≥ 51 and < 75 gallons	$0.9307 - (0.0002 \times v_t)$
		≥ 75 gallons	$0.9349 - (0.0001 \times v_t)$
	> 55 gal and ≤ 120 gal	< 18 gallons	$1.9236 - (0.0011 \times v_t)$
		≥ 18 and < 51 gallons	$2.0440 - (0.0011 \times v_t)$
		≥ 51 and < 75 gallons	$2.1171 - (0.0011 \times v_t)$
		≥ 75 gallons	$2.2418 - (0.0011 \times v_t)$
Gas-Fired Storage Water Heater	≥ 20 gal and ≤ 55 gal	< 18 gallons	$0.3456 - (0.0020 \times v_t)$
		≥ 18 and < 51 gallons	$0.5982 - (0.0019 \times v_t)$
		≥ 51 and < 75 gallons	$0.6483 - (0.0017 \times v_t)$
		≥ 75 gallons	$0.6920 - (0.0013 \times v_t)$
	> 55 gal and ≤ 100 gal	< 18 gallons	$0.6470 - (0.0006 \times v_t)$
		≥ 18 and < 51 gallons	$0.7689 - (0.0005 \times v_t)$
		≥ 51 and < 75 gallons	$0.7897 - (0.0004 \times v_t)$
		≥ 75 gallons	$0.8072 - (0.0003 \times v_t)$

Table 2-157 Efficient UEF

Product Class	Criteria	UEF
Electric Storage Water Heater	Integrated HPWH	3.30
	Integrated HPWH, 120 Volt/15 Amp Circuit	2.20
	Split-system HPWH	2.20

Table 2-158 Derating Factors

Area	F_{derate}	$F_{location}$
Unconditioned Basement	0.86	0
Garage	0.83	0
Conditioned Space	1.00	1.00

Table 2-159 SEER and HSPF Values

Type	SEER	HSPF
Air-Source Heat Pump	14.0	8.0
Ground-Source Heat Pump	15.0	10.9
CAC	14.0	N/A
Mini Split HP	15.0	8.8

Table 2-160 AFUE Values

Equipment Type	Size Range	AFUE
Warm Air Furnace, Gas Fired	All Capacities	0.80
Boiler, Hot Water, Gas Fired	All Capacities	0.82
Boiler, Steam, Gas Fired	All Capacities	0.80

Peak Factors

Peak coincidence is accounted for in the peak demand savings algorithm section above.

Table 2-161 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-162 Measure Life

Equipment	EUL	RUL	Ref
Heat Pump Water Heater	10	3.33	[218]

References

[210] EmPOWER heat pump water heater program participation in 2018-2019 and participant survey data; per Mid-Atlantic TRM v10, pg. 150. https://neep.org/sites/default/files/media-files/trmv10.pdf

[211] NMR Group, Inc., 2018 Pennsylvania Statewide Act 129 Residential Baseline Study (Feb 2018). https://www.puc.pa.gov/Electric/pdf/Act129/SWE-Phase3_Res_Baseline_Study_Rpt021219.pdf

[212] Using Rock Spring, PA (Site 2036) as a proxy, the mean of soil temperature at 40 inch depth is 51.861. Calculated using Daily SCAN Standard - Period of Record data from April 1999 to December 2018 from the Natural Resource Conservation Service Database. https://wcc.sc.egov.usda.gov/nwcc/rgrpt?report=daily_scan_por&state=PA. Methodology follows Missouri TRM 2017 Volume 2: Commercial and Industrial Measures. p. 78. https://energy.mo.gov/sites/energy/files/MOTRM2017Volume2.pdf

[213] 10 CFR Subpart C of Part 430, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[214] 10 CFR Subpart B of Part 429, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-429/subpart-B/section-429.17

[215] Bonneville Power Administration, Residential Heat Pump Water Heater Evaluation: Lab Testing & Energy Use Estimates. (November 2011), https://rpsc.energy.gov/sites/default/files/tech-resource/attachment/BPA_HPWH_Lab_Evaluation_11-9-2011.pdf

[216] Fluid Market Strategies, NEEA Heat Pump Water Heater Field Study Report. (2013), https://neea.org/img/uploads/heat-pump-water-heater-field-study-report.pdf

[217] ENERGY STAR Program Requirements Product Specification for Residential Water Heaters, Eligibility Criteria, Version 4.0. (2021), https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%204.0%20Water%20Heaters%20Final%20Specification%20and%20Partner%20Commitments_0.pdf

[218] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[219] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household, April 2016

2.7.2 INDIRECT WATER HEATER

Market	Residential/Multifamily
Baseline Condition	TOS/NC/EREP
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	December 2022

Description

This measure covers the installation of a fossil fuel indirect-fired storage water heating system in which the stored water is heated via hot water produced by a fossil fuel boiler rather than direct input from electric elements or fossil fuel burners. In such a system, a heat exchanger separates the potable water in the water heater from the boiler water. This measure applies to indirect-fired systems comprising a boiler with input heating capacity less than 300,000 Btu/h and a storage tank with a capacity of 20 to 120 gallons installed in residential applications.

This measure estimates savings associated with the delivery of potable hot water only and assumes the installation of zone priority controls to interrupt demand for space heating hot water until domestic hot water demand is met.

Baseline Case

The baseline condition is a minimally code-compliant indirect fired, fossil fuel storage type water heater with a recovery efficiency of 75%, tank volume equal to the energy efficient condition.

Efficient Case

Theefficient case is an indirect fossil fuel-fired water heating system with efficiency meeting or exceeding 0.85 AFUE.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = units \times \left(\frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left(\frac{1}{Eff_b} - \frac{1}{Eff_q} \right) + \left(\frac{UA_b}{Eff_b} - \frac{UA_q}{Eff_q} \right) \times \frac{\Delta T_{amb} \times 8{,}760}{100{,}000} \right)$$

Where,

$$\Delta T_{main} = T_{set} - T_{main}$$

$$\Delta T_{amb} = T_{set} - T_{amb}$$

$$GPD = 17.2 \times N_{ppl}$$

$$UA_q = \frac{SL_q}{70} \times v_q \times 8.33$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-163 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
GPD	Gallons per day	Calculated, if N_{ppl} unknown use 46	Gal/day	[220]

Variable	Description	Value	Units	Ref
ΔT_{main}	Average temperature difference between water heater set point temperature (T_{set}) and the supply water temperature in water main (T_{main})	Calculated	°F	
ΔT_{amb}	Average temperature difference between water heater set point temperature (T_{set}) and the surrounding ambient air temperature (T_{amb})	Calculated	°F	
UA_q	Overall heat loss coefficient of the energy efficient equipment	Calculated, if SL_q unknown use 5.4	(Btu/h-°F).	[225]
Eff_q	Efficiency of energy efficient connected boiler (AFUE)	Site-specific. If unknown use 0.85[43]	N/A	
N_{ppl}	Number of people in household	Site-specific, if unknown use default 2.65	N/A	[225]
SL_q	Standby loss specification of installed equipment. Use given UAq assumption if SLq is unknown.	Site-specific	°F/hr	
v_q	Rated storage capacity of installed equipment	Site-specific	Gal	
UA_b	Overall heat loss coefficient of the baseline condition	7.85	(Btu/h-°F).	[223]
T_{set}	Water heater set point temperature	125	°F	[221]
T_{main}	Supply water temperature in water main	60	°F	[222]
T_{amb}	Surrounding ambient air temperature	70[44]	°F	
Eff_b	Efficiency of the baseline condition, deemed (AFUE)	0.75	N/A	[223]
365	Days per year	365	Days/yr	
8,760	Hours per year	8,760	Hr/yr	
8.33	Energy required (Btu) to heat one gallon of water by one degree Fahrenheit	8.33	Btu/gal°F	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

[43] ASHRAE 90.1 2019 Compliant AFUE values range from 82% to 84%. Assumed conservative estimate of 85%

[44] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating ambient air temperature

Peak Factors

Table 2-164 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-165 Measure Life

Equipment	EUL	RUL	Ref
Indirect Water Heater	11	3.67	[226]

References

[220] Water Research Foundation: *Residential End Uses of Water*, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household, April 2016

[221] Code of Federal Regulations, Title 10, Chapter II, Subchapter D, Part 430, Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature, December 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B.

[222] Burch, Jay and Christensen, Craig, *Towards Development of an Algorithm for Mains Water Temperature*. National Renewable Energy Laboratory, 2022.

[223] Per 10 CFR 430, typical recovery efficiency of a gas water heater, which is used for the purposes of this measure as a proxy for thermal efficiency, is 0.75. See for example, 10 CFR 430 Subpart B Appendix C1, 5.6.1.1., December 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B.

[224] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment, December 2022.

[225] Based on the average standby loss specification (in °F/hr) of AHRI-certified Indirect Water Heater storage tanks, per the AHRI Directory, Air Conditioning, Heating, and Refrigeration Institute, December 2022. https://ahridirectory.org.

[226] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 9, January 2022. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf

2.7.3 STORAGE WATER HEATER

Market	Residential/Multifamily
Baseline Condition	NC/TOS
Baseline	Code
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of storage tank water heaters designed to heat and store water at a thermostatically controlled temperature. This measure applies to potable hot water delivery only; it is not applicable to hot water heaters used for process loads or space heating. Additionally, qualifying equipment must be designed to heat water to a temperature no greater than 180°F.

Storage type units include residential gas storage water heaters with an input of 75,000 Btu per hour or less.

This measure applies to replacement of existing storage type water heaters using the same heating fuel as the efficient case and assumes baseline to be a minimally code compliant water heater of the same type and heating fuel as the efficient case. For new construction, this measure assumes baseline to be a minimally code compliant storage-type water heater using the same heating fuel as the efficient case.

Baseline Case

The baseline condition is a minimally code compliant water heater equivalent to the existing water heater and with tank volume, input capacity and draw pattern equivalent to the efficient water heater. For new construction, the baseline condition is a minimally code compliant storage-type water heater with tank volume, input capacity and draw pattern equivalent to the efficient water heater.

Efficient Case

The compliance condition is an ENERGY STAR® rated gas storage water heater as directed by the measure description. Efficient storage tank water heaters must be eligible under ENERGY STAR® Program Requirements for Residential Water Heaters, Eligibility Criteria Version 5.0, effective April 2023. [232] Minimum UEF qualification for ENERGY STAR® equipment is shown in Table 2-167.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left(\frac{1}{UEF_b} - \frac{1}{UEF_q}\right)$$

Where,

$$GPD = 17.2 \times N_{ppl}$$

$$\Delta T_{main} = T_{set} - T_{main}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \mathrm{N/A}$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-166 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
GPD	Gallons per day	Calculated, if unknown use 46	Gal/day	[227]
ΔT_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main	Calculated	°F	
UEF_q	Uniform Energy Factor of the energy efficient measure	Site-specific, if unknonwn look up in Table 2-167	N/A	
N_{ppl}	Number of people served by the system	Site-specific, if unknown use default 2.65	persons	[227]

Variable	Description	Value	Units	Ref
T_{set}	Water heater set point temperature	125	°F	[228]
T_{main}	Supply water temperature in water main[45]	60	°F	[229]
UEF_b	Uniform Energy Factor of the baseline condition, based on tank volume	Look up in Appendix E: Code-Compliant Efficiencies	N/A	
8,760	Hours per year	8,760	Hours/yr	
365	Days per year	365	Days/yr	
3,412	Conversion from Btu to kWh	3,412	Btu/kWh	
8.33	Energy required (Btu) to heat one gallon of water by one degree Fahrenheit	8.33	Btu/gal°F	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
17.2	Assumed gallons of hot water used per day per person in household	17.2	Gal/day/person	[227]
CF	Electric coincidence factor	Look up in Table 2-168	N/A	
PDF	Gas peak day factor	Look up in Table 2-168	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-167 Residential Water Heaters Energy Star Criteria

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	Minimum UEF
Gas-Fired Storage Water Heater	> 20 gal and ≤ 55 gal	Medium	0.81
	> 20 gal and ≤ 55 gal	High	0.86
	> 55 gal	Medium	0.86

Peak Factors

Table 2-168 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[231]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

[45] Average value across NJ climate zones, calculated as average ambient air temperature + 6 °F.

Measure Life

The effective useful life (EUL) is 11 years for gas water heaters and 13 years for electric water heaters. [230]

References

[227] Water Research Foundation: “Residential End Uses of Water, Version 2: Executive Report”, April 2016, https://www.mrwa.com/PDF/2016WaterEndUseReport.pdf

[228] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature https://www.ecfr.gov/current/title-10/chapter-II/subcharpter-D/part430/sybpart-B/appendix-E

[229] Calculated from annual NJ temperatures using methodology in Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022

[230] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

[231] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 9, January 2022. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf.

[232] Energy Star Residential Water Heaters Specification Final Draft v5.0 https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%205.0%20Residential%20Water%20Heaters%20Final%20Draft%20Specification.pdf

2.7.4 TANKLESS WATER HEATER

Market	Residential/Multifamily
Baseline Condition	NC/RF/DI
Baseline	Code/Existing/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	December 2022

Description

This measure covers the installation of instantaneous type water heaters, which heat water but contain no more than one gallon of water per 4,000 Btu per hour of input. This measure applies to potable hot water delivery only; it is not applicable to hot water heaters used for process loads or space heating. Additionally, qualifying equipment must be designed to heat water to a temperature no greater than 180°F and, if electric power is required for operation, must use a single-phase external power supply.

Instantaneous type units include fossil fuel instantaneous water heaters with a rated input capacity of greater than or equal to 50,000 and less than 200,000 Btu per hour and a manufacturer's specified storage capacity of less than 2 gallons, residential electric instantaneous water heaters with an input of 12 kilowatts or less and a manufacturer's specified storage capacity of less than 2 gallons.

Baseline Case

The retrofit baseline condition is a minimally code compliant water heater of type (storage-type or instantaneous) equivalent to the existing water heater and with tank volume (where applicable), input capacity and draw pattern equivalent to the efficient water heater. For new construction, the baseline condition is a minimally code compliant 40-gallon storage-type with draw pattern equivalent to the efficient water heater (assume medium if unknown).

Efficient Case

The efficient case is an energy efficient fossil fuel or electric instantaneous type water heater as defined by the measure description.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

Where,

$$kWh_b = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412 \times UEF_b} \ (Electric\ Baseline)$$

$$kWh_b = \ 0 \ (Fossil\ Fuel\ Baseline)$$

$$kWh_q = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412 \times UEF_q} (Electric\ Energy\ Efficient\ Case)$$

$$kWh_q = \ 0 \ (Fossil\ Fuel\ Energy\ Efficient\ Case)$$

$$GPD = 17.2 \times N_{ppl}$$

$$\Delta T_{main} = T_{set} - T_{main}$$

$$\Delta T_{amb} = T_{set} - T_{amb}$$

Annual Fuel Savings

$$\Delta Therms = Therms_b - Therms_q$$

Where,

$$Therms_b = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000 \times UEF_b} \ (Fossil\ Fuel\ Baseline)$$

$$Therms_b = 0 \ (Electric\ Baseline)$$

$$Therms_q = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000 \times UEF_q} \ (Fossil\ Fuel\ Energy\ Efficient\ Case)$$

$$Therms_q = 0 \ (Electric\ Energy\ Efficient\ Case)$$

$$GPD = 17.2 \times N_{ppl}$$

$$\Delta T_{main} = T_{set} - T_{main}$$

$$\Delta T_{amb} = T_{set} - T_{amb}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\left(UA_b - UA_q\right) \times \Delta T_{amb}}{3{,}412} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms - day_{peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-169 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms\text{-}day_{Peak}$	Daily peak fuel savings	N/A	Therms/day	
ΔT_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)	Calculated	°F	
ΔT_{amb}	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)	Calculated	°F	
GPD	Gallons per day	Calculated, if N_{ppl} unknown, use 46	Gal/day	[233]
N_{ppl}	Number of people in household	Site-specific. If unknown, use 2.65	N/A	[240]
T_{set}	Water heater set point temperature	Site-specific. If unknown, use 125	°F	[234]
T_{main}	Supply water temperature in water main	60	°F	[235]
T_{amb}	Surrounding ambient air temperature	70	°F	
UEF_b	Uniform Energy Factor of the baseline condition	Retrofit: Site-specific	N/A	[238]

Variable	Description	Value	Units	Ref
		New construction: Look up in Appendix E: Code-Compliant Efficiencies		
UEF_q	Uniform Energy Factor of the energy efficient measure.	Site-specific	N/A	
UA_b	Overall heat loss coefficient of the baseline condition.	Storage water heater baseline: UA_b = 7.85 Indirect water heater baseline: UA_b = 0	(Btu/h-°F).	[236]
UA_q	Overall heat loss coefficient of the energy efficient measure.	0	(Btu/h-°F).	[237]
365	Days per year	365	Days/yr	
3,412	Conversion from Btu to kWh	3,412	Btu/kWh	
8.33	Energy required (Btu) to heat one gallon of water by one degree Fahrenheit	8.33	Btu/gal-°F	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 2-170	N/A	
PDF	Peak day factor	Look up in Table 2-170	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 2-170 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[239]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for retrofit projects is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-171 Measure Life

Equipment	New construction EUL	Retrofit RUL	Ref
Instantaneous Water Heater	20	6.66	[239]

References

[233] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household, April 2016.

[234] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature, December 2022.

[235] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022.

[236] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment, December 2022.

[237] Based on the average standby loss specification (in °F/hr) of AHRI-certified Indirect Water Heater storage tanks, per the AHRI Directory, December 2022.

[238] 10 CFR 430.32(d), December 2022.

[239] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 9, January 2022. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf

[240] *Residential End Uses of Water: Version 2 Executive Report (Water Research Foundation)*, Pg 8. https://www.circleofblue.org/wp-content/uploads/2016/04/WRF_REU2016.pdf

2.7.5 WATER HEATING SETBACK

Market	Residential/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	December 2022

Description

This measure relates to turning down an existing hot water tank thermostat setting that is at 130 degrees or higher. Savings are provided to account for the resulting reduction in standby losses. This is a retrofit measure.

Baseline Case

The baseline condition is a hot water tank with a thermostat setting that is 130 degrees or higher. Note if there are more than one DHW tanks in the home at or higher than 130 degrees and they are all turned down, then the savings per tank can be multiplied by the number of tanks.

Efficient Case

The efficient condition is a hot water tank with the thermostat reduced to no lower than 120 degrees.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{U \times A \times \left(T_b - T_q\right) \times Hrs}{3{,}412 \times RE_{electric}}\right)$$

Annual Fuel Savings

$$\Delta Therms = \left(\frac{U \times A \times \left(T_b - T_q\right) \times Hrs}{1{,}00{,}000 \times RE_{gas}}\right)$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-172 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms\text{-}day_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta kWh_{Lifetime}$	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Lifetime}$	Lifetime fuel savings	Calculated	Therms	
U	Overall heat transfer coefficient of tank	Site-specific, if unknown use 0.083[46]	(Btu/Hr-°F-ft^2)	
A	Surface area of storage tank	Site-specific, if unknown look up in Table 2-173	Ft^2	[241]
T_b	Hot water setpoint prior to adjustment	Site-specific, if unknown use 130	°F	[244]
T_q	New hot water setpoint	Site-specific, if unknown, use 120	°F	[243]
Hours	Number of hours in a year	8760	Hrs/yr	

[46] Assumes R-12 water tank

Variable	Description	Value	Units	Ref
$RE_{electric}$	Recovery efficiency of water heater	Electric Hot Water Heater: 0.98 Heat Pump Water Heater: 2.1	N/A	[241]
RE_{gas}	Recovery efficiency of gas water heater	0.8	N/A	[242]
3,412	Conversion from Btu to kWh	3,412	Btu/kWh	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 2-174	N/A	
EUL	Effective useful life	See Measure Life	Years	
RUL	Remaining useful life of existing unit	See Measure Life	Years	

Table 2-173 Assumed Surface Area of Storage Tank by Capacity

Capacity (in gallons)	Area (in square feet)
30	19.16
40	23.18
50	24.99
80	31.84

If capacity is unknown, assume a 50 gallon tank.

Peak Factors

Table 2-174 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life for water heating setback is the smaller of 2 years or the remaining useful life of the water heater [243].

References

[241] Assumptions from Pennsylvania TRM. Area values were calculated from average dimensions of several commercially available units, with radius values measured to the center of the insulation, December 2022. https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/Code of Federal Regulations, Title 10, Chapter II, Subchapter D, Part 430, Subpart B, Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters: *6.3.2 Recovery Efficiency,* December 2022.

https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B#Appendix-E-to-Subpart-B-of-Part-430.

[242] Code of Federal Regulations, Title 10, Chapter II, Subchapter D, Part 431, Section 431.110 (a) – Energy Conservation Standards and their Effective Dates. December 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431#431.110.

[243] Mid-Atlantic TRM V10, December 2022. https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf.

[244] *Technical Reference Manual Volume 2: Residential Measures (2019)*; Pg 73, https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

2.7.6 FAUCET AERATORS AND SHOWERHEADS

Market	Residential/Multifamily
Baseline Condition	DI/TOS
Baseline	Existing/Dual
End Use Subcategory	Water Conservation
Measure Last Reviewed	December 2022

Description

This measure presents the assumptions, analysis, and savings from adding low-flow aerators to faucets in kitchens and bathrooms, and for replacing standard showerheads with low-flow showerheads.

Savings for low-flow fixture measures are determined using the total change in flow rate (gallons per minute) from the baseline (existing) fixture to the low-flow fixture. This measure applies to residential and multifamily buildings.

Baseline Case

The baseline is a standard faucet with a 2.2 GPM flow rate or a standard showerhead meeting federal maximum flow of 2.5 GPM. For direct install programs, utilities may choose to measure the actual flow rate of the existing faucet for use in the algorithm below.

Efficient Case

The efficient condition is an energy efficient faucet aerator or showerhead using rated GPM of the installed fixture meeting requirements of NJ P.L. 2021, c. 464. If actual flow rates of the baseline fixtures are used in a direct install program, then the actual flow rate of the installed fixture should be used as well.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta H_2O \times \Delta T_{main} \times \frac{8.33}{3{,}412} \times \frac{1}{UEF} \times F_{elec}$$

Where,

$$\text{Aerators: } \Delta T_{main} = T_{faucet} - T_{main}$$

$$\text{Showerheads: } \Delta T_{main} = T_{shower} - T_{main}$$

$$\text{Aerators: } \Delta H_2O = \left(GPM_b \times F_{Throttle,b} - GPM_q \times F_{Throttle,q}\right) \times \frac{1}{N_{faucet}} \times t_{use} \times N_{persons} \times 365$$

$$\text{Showerheads: } \Delta H_2O = \left(GPM_b \times F_{Throttle,b} - GPM_q \times F_{Throttle,q}\right) \times \frac{1}{N_{shower}} \times t_{use} \times N_{persons} \times 365$$

Annual Fuel Savings

$$\Delta Therms = \Delta H_2O \times \Delta T_{main} \times \frac{8.33}{100{,}000} \times \frac{1}{UEF} \times F_{gas}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh \times ETDF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-175 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	

Variable	Description	Value	Units	Ref
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔH20	Annual water savings	Calculated	Gal/yr	
ΔT_{main}	Average temperature different between faucet operating temperature and the supply water temperature	Calculated	°F	
UEF	Uniform Energy Factor[47]	Site-specific. If unknown, assume 0.92 (electric) or 0.58 (gas)	N/A	[252]
F_{elec}	Factor to account for presence or absence of electric water heater	1 if electric water heater; 0 if gas water heater; if unknown look up in Appendix K: DHW and Space Heat Fuel Split or default[48] = 0.25	N/A	
F_{gas}	Factor to account for presence or absence of fossil fuel water heater	1 if gas water heater; 0 if electric water heater; if unknown look up in Appendix K: DHW and Space Heat Fuel Split or default[49] = 0.71	N/A	
N_{faucet}	Faucets per household	Site-specific. If unknown, look up in Table 2-176	N/A	[251]
N_{shower}	Showers per household	Site-specific, if unknown: QHEC: 1.56 HPwES: 2.46	N/A	[256]
$N_{persons}$	Average number of people per household	Site-specific. If unknown, assume 2.66	Person/ household	[245]
GPM_b	Baseline GPM	Site-specific or use 2.2	Gal/min	[250][247]
GPM_q	Efficient GPM	Look up in Table 2-176	Gal/min	[250]
t_{use}	Average minutes of use per person per fixture per day	Look up in Table 2-176	Minutes/ person/day	[246]

[47] Take UEF from application using the existing water heater's model number lookup. If unknown, then UEF is determined by the Department of Energy's test method outlined in 10 CFR Part 430, Subpart B, Appendix E (accessible here: https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32).
Assume medium draw pattern if unknown. If storage capacity is also unknown, use the assumptions above for a 40 gallon, medium draw, electric or gas storage water heater.

[48] From 2015 RECS microdata for Middle Atlantic Div 8. Of 228 households, fuel mix for water heating is 71% gas and 25% electric. No savings are attributed to 4% of households which use other fuel sources.

[49] From 2015 RECS microdata for Middle Atlantic Div 8. Of 228 households, fuel mix for water heating is 71% gas and 25% electric. No savings are attributed to 4% of households which use other fuel sources.

Variable	Description	Value	Units	Ref
$F_{throttle, b}$	Ratio of user setting to full throttle flow rate for baseline fixture	Aerator: 0.83 Showerhead: 0.9	N/A	[249], [257]
$F_{throttle, q}$	Ratio of user setting to full throttle flow rate for low flow fixture	Aerator: 0.95 Showerhead: 0.9	N/A	[249], [257]
T_{Main}	Supply water temperature in water main[50]	60	°F	[248]
T_{faucet}	Faucet exiting temperature	Site-specific. If unknown, look up in Table 2-176	°F	[253]
T_{shower}	Showerhead existing temperature	Site specific, use 105 if unknown	°F	[255]
ETDF	Energy to Demand Factor	Aerator: 0.000134 Showerhead: 0.00008014	(kW/kWh/yr)	[247]
8.33	Energy required to heat one gallon of water by one degree Farenheit	8.33	Btu/gal°F	
3,412	Conversion factor from Btu/h to kW	3,412	Btu/h/kW	
100,000	Conversion factor from Btu to therms	100,000	Btu/therm	
365	Number of days per year	365	Days/yr	
PDF	Peak day factor	Look up in Table 2-177		
EUL	Effective useful life	See Measure Life Section		
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 2-176 Calculation Assumptions per Faucet Type

Faucet Type	Efficient gallons per minute (GPM_q)	Daily use duration (t_{use})	Operating temperature (T_{faucet}) (°F)	Faucets/household (N_{faucet})
Kitchen	1.8	4.5	93	1
Private restroom	1.5	1.6	86	1.75
Public restroom	0.5	1.6	86	N/A

Peak Factors

Electric coincidence is included in the ETDF factor.

[50] Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F. See Reference [248].

Table 2-177 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-178 Measure Life

Equipment	EUL	RUL	Ref
Faucet Aerator	10	3.3	[254]

Non-Energy Impacts

$$\Delta H_2O = \left(GPM_b \times F_{Throttle,b} - GPM_q \times F_{Throttle,q}\right) \times \frac{1}{N_{faucet}} \times t_{use} \times N_{persons} \times 365$$

References

[245] Explore Census Data. n.d. Data.census.gov. Accessed December 1, 2022. https://data.census.gov/table?q=average+household+size&g=0400000US34&y=2020&tid=ACSDT5Y2020.B25010

[246] Cadmus, *2014 Demand-Side Management Evaluation Final Report* (2014), Table 93.

[247] Pennsylvania Technical Reference Manual; effective June 2016, pp. 114ff. http://www.puc.pa.gov/pcdocs/1370278.docx

[248] Burch, Jay and Christensen, Craig, *Towards Development of an Algorithm for Mains Water Temperature*. National Renewable Energy Laboratory. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.515.6885&rep=rep1&type=pdf

[249] American Council for an Energy-Efficient Economy, *Energy Related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes*, August 2008, pg. 1-265.

[250] Baseline flow rates for new aerators established by New Jersey P.L. 2021, c. 464 minimum standards.

[251] American Housing Survey Table Creator, United States Census Bureau, Housing Unit Characteristics, New York 2017.

[252] UEF assumptions per 10 CFR Part 430, Subpart B, Appendix E. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32; assuming medium draw pattern, 40 gallon storage water heater.

[253] *Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study.* June 2013, via 2014 Demand-Side Management Evaluation Final Report, Cadmus, June 30, 2015, Table 93.

[254] DEER 2014 EUL ID: WtrHt-WH-Aertr.

[255] Lutz, Jim. 2011. "Water and Energy Wasted during Residential Shower Events: Findings from a Pilot Field Study of Hot Water Distribution Systems." https://eta-

publications.lbl.gov/sites/default/files/water_and_energy_wasted_during_residential_shower_events_findings_from_a_pilot_field_study_of_hot_water_distribution_systems_lbnl-5115e.pdf.

[256] American Housing Survey (AHS) - AHS Table Creator." n.d. Www.census.gov. Accessed December 1, 2022. https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=35620&s_year=2021&s_tablename=TABLE0&s_bygroup1=1&s_bygroup2=1&s_filtergroup1=1&s_filtergroup

[257] Biermayer, Peter, and Ernest Lawrence. 2006. "LBNL-58601-Revised Potential Water and Energy Savings from Showerheads." https://www.map-testing.com/assets/reports/LBNL%20Showerhead-final%20rpt.pdf.

2.7.7 THERMOSTATIC SHOWERHEADS

Market	Residential/Multifamily
Baseline Condition	RF/DI
Baseline	Existing
End Use Subcategory	Water Conservation
Measure Last Reviewed	December 2022

Description

This measure covers the installation of thermostatic shower restriction valves, which are valves attached to a showerhead supply for reduction of domestic hot water flow and associated energy usage in a single or multifamily household.

The device restricts hot water flow through the showerhead by activating the trickle or stop flow mode when water reaches a predetermined set temperature, as designed by the manufacturer.

The throttle factor should be used only when rated flows are used and not the actual measured flow.

Baseline Case

The baseline equipment is the residential showerhead without the restrictor valve installed.

Efficient Case

To qualify for this measure the installed equipment must be a thermostatic restrictor shower valve installed on a residential showerhead.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = GPM \times F_{Throttle} \times Min_{Waste} \times \frac{Person}{Household} \times \frac{Showers}{Person/Day} \times \frac{365}{N_{Shower}} \times 8.33 \times \frac{T_{Shower} - T_{Main}}{UEF \times 3{,}412} \times ISR \times F_{Elec}$$

Annual Fuel Savings

$$\Delta Therms = GPM \times F_{Throttle} \times Min_{Waste} \times \frac{Person}{Household} \times \frac{Showers}{Person/Day} \times \frac{365}{N_{Shower}} \times 8.33 \times \frac{T_{Shower} - T_{Main}}{UEF \times 100{,}000} \times ISR \times F_{NG}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh \times ETDF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-179 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{life}$	Lifetime fuel savings	Calculated	Therms	
GPM	Flow rate of the showerhead	Site-specific, if unknown look up in Table 2-180	Gal/min	[258][265]
Person/Household	Average number of people per household	Site-specific, if unknown assume 2.66	Person/ household	[260]
Showers/person/day	Showers Per Capita Per Day	Site-specific, if unknown assume 0.75	Showers/person/day	[261]

Variable	Description	Value	Units	Ref
N_{Shower}	Average number of showerheads Per Household	Site-specific, if unknown assume 1.10	N/A	[262]
UEF	Uniform Energy Factor	Site-specific, if unknown assume 0.92 (electric) or 0.58 (gas)	N/A	[266]
F_{Elec}	Water heater fuel factor - electric	Look up in Table 2-181	N/A	
F_{NG}	Water heater fuel factor - gas	Look up in Table 2-181	N/A	
$F_{Throttle}$	Ratio of actual shower gpm to showerhead rated gpm	0.9	N/A	[261]
Min_{Waste}	Hot water waste time avoided due to thermostatic restrictor valve	0.98	Minutes	[259]
T_{Shower}	Temperature at showerhead	105	°F	[263]
T_{Main}	Supply water temperature in water main[51]	60	°F	
ISR	In-Service Rate	Look up by program in Appendix J: In-Service Rates, or use default value = 1	N/A	
8.33	Energy required to heat one gallon of water by one degree Farenheit	8.33	Btu/gal°F	
3,412	Conversion factor from Btu/h to kW	3,412	Btu/h/kW	
100,000	Conversion factor from Btu to therms	100,000	Btu/therm	
365	Number of days per year	365	Days/yr	
ETDF	Energy to Demand Factor	0.00008014	(kW/ kWh/yr)	[264]
CF	Electric coincidence factor	Look up in Table 2-182	N/A	
PDF	Gas peak demand factor	Look up in Table 2-182	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

[51] Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F.

Table 2-180 GPM

Installation case	GPM
Existing Showerhead	2.5
New Conventional Showerhead	2.0
Low Flow Showerhead	1.5

Table 2-181 Water Heater Fuel Factors

Water Heater Fuel Type	F_{Elec}	F_{NG}
Electric	1	0
Gas	0	1
Unknown	Look up in Appendix K: DHW and Space Heat Fuel Split or default = 0.18	Look up in Appendix K: DHW and Space Heat Fuel Split or default = 0.82

Peak Factors

Table 2-182 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A[52]	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Table 2-183 Measure Life

Equipment	EUL	RUL	Ref
Thermostatic Showerheads	10	3.3	[267]

References

[258] Cadmus and Opinion Dynamics Evaluation Team. *Showerhead and Faucet Aerator Meter Study: For Michigan Evaluation Working Group.* (June, 2013).

[259] Cadmus memo to PPL Electric. *PPL Electric 2014 ShowerStart Pilot Study*. (November 2014).

[260] Explore Census Data." n.d. Data.census.gov. Accessed December 1, 2022. https://data.census.gov/table?q=average+household+size&g=0400000US34&y=2020&tid=ACSDT5Y2020.B25010.

[52] Peak electric demand embedded in ETDF.

[261] Biermayer, Peter. 2006. "LBNL-58601-Revised Potential Water and Energy Savings from Showerheads." https://www.map-testing.com/assets/reports/LBNL%20Showerhead-final%20rpt.pdf.

[262] American Housing Survey (AHS) - AHS Table Creator." n.d. Www.census.gov. Accessed December 1, 2022. https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=35620&s_year=2021&s_tablename=TABLE0&s_bygroup1=1&s_bygroup2=1&s_filtergroup1=1&s_filtergroup

[263] Lutz, Jim. 2011. "Water and Energy Wasted during Residential Shower Events: Findings from a Pilot Field Study of Hot Water Distribution Systems." https://eta-publications.lbl.gov/sites/default/files/water_and_energy_wasted_during_residential_shower_events_findings_from_a_pilot_field_study_of_hot_water_distribution_systems_lbnl-5115e.pdf.

[264] Aquacraft, Inc., Water Engineering and Management. The end use of hot water in single family homes from flow trace analysis. 2001. https://www.researchgate.net/publication/252083793_THE_END_USES_OF_HOT_WATER_IN_SINGLE_FAMILY_HOMES_FROM_FLOW_TRACE_ANALYSIS The CF for showerheads is found to be 0.00371: [% showerhead use during peak × (TPerson-Day× NPerson) /(S/home)] / 240 (minutes in peak period) = [11.7% × (7.8 x 2.6 x 0.6 / 1.6)] / 240 = 0.00371. The Hours for showerheads is found to be 46.3: (TPerson-Day× NPersons× 365) /(S/home) / 60 = (7.8 x 2.6 x 0.6 x 365) / 1.6 / 60 = 46.3. The resulting FED is calculated to be 0.00008013: CF / Hours = 0.00371 / 46.3 = 0.00008013.

[265] Maximum flowrates for new showerheads taken from New Jersey P.L. 2021, c. 464 Enacted January 2022. https://legiscan.com/NJ/bill/A5160/2020

[266] Take UEF from application using the existing water heater's model number lookup. If unkown, then UEF is determined by the Department of Energy's test method outlined in 10 CFR Part 430, Subpart B, Appendix E (accessible here: https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32). Assume medium draw pattern if unknown. If storage capacity is also unknown, use the assumptions above for a 40 gallon, medium draw, electric or gas storage water heater.

[267] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

2.7.8 PIPE INSULATION

Market	Residential/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Insulation
Measure Last Reviewed	November 2022

Description

This measure covers the installation of fiberglass, rigid foam, and cellular glass pipe insulation on exposed and uninsulated metal or steel piping with a nominal diameter between 0.50" and 4.00" for hot water and steam type space heating and/or domestic hot water (DHW) distribution systems in residential buildings. The measure is restricted to insulation of hot water distribution pipe in unconditioned spaces only. Space heating pipe insulation is limited to insulation installed in unheated spaces only. Insulation of CPVC, PEX, and HDPE piping is not eligible for savings under this measure due to low potential of savings.

In New Jersey the 2021 International Energy Conservation Code (IECC) generally defines the residential energy efficiency code requirements, but the IECC does not include residential service water heating provisions, leaving federal equipment efficiency standards to define baseline.

This measure caters for all insulation type given that they are IECC 2021 code compliant and are installed by certified professionals. The R-value of an insulation is the thermal resistance of its constituent material, which is derived by dividing the thickness of the material by the material's thermal conductivity, or k-value. Thermal transmittance, or the material's U-factor, is the inverse of the R-value.

Baseline Case

The baseline condition is uninsulated copper or steel domestic hot water or space heating piping located in an unconditioned space.

Efficient Case

The efficient case is insulated copper or steel domestic hot water or space heating piping located in an unconditioned space conforming to the requirements of IECC 2021 Section R403.5.2 which require hot water piping with 3/4" nominal diameter and larger to be insulated with a minimum thermal resistance of R-3.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \frac{\left[\left(\frac{UA}{L}\right)_b - \left(\frac{UA}{L}\right)_q\right] \times L \times \left(T_{pipe} - T_{amb}\right) \times hrs \times SF_{elec}}{Et_{elec} \times 3{,}412}$$

Annual Fuel Savings

$$\Delta Therms = \frac{\left[\left(\frac{UA}{L}\right)_b - \left(\frac{UA}{L}\right)_q\right] \times L \times (T_{pipe} - T_{amb}) \times hrs \times SF_{fuel}}{Et_{fuel} \times 100{,}000}$$

Peak Demand Savings

$$\Delta kW_{peak} = \frac{\Delta kWh}{8{,}760} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 2-184 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	

Variable	Description	Value	Units	Ref
L	Length of installed insulation	Site-specific	ft	
T_{pipe}	Average temperature of hot water or steam in distribution system piping	Site-specific, if unknown: DHW: 125 HW Boiler[53]: 160 Steam Boiler[54]: 212	°F	[272]
T_{amb}	Surrounding average ambient air temperature	Site-specific, if unknown: DHW: 70 Space Heat: 50	°F	[275]
Et_{fuel}	Recovery Efficiency of fuel water heaters or AFUE of boiler for space heating	Site-specific, if unknown: DHW[55]: 0.75 Space Heating Boilers: Look up in Table 2-187	N/A	[270][277]
Et_{elec}	Recovery Efficiency of electric water heaters	Site-specific, if unknown: Non- Heat Pump DHW[56]: 0.98 Heat Pump DHW: Look up in Table 2-188	N/A	[271][273]
hrs	Annual operating hours	For DHW: 8,760 Boilers: Look up heating EFLH in Appendix C: Heating and Cooling EFLH	hrs	[278]
$(UA/L)_b$	Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from uninsulated pipe[57]	Look up in Table 2-185	Btu/hr-°F-ft	[274]
$(UA/L)_q$	Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from insulated pipe[57]	Look up in Table 2-186	Btu/hr-°F-ft	[279]
SF_{elec}	Adjustment to electric water heating energy savings based on water heating fuel	Electric WH: 1.0 Fossil Fuel WH: 0 Unknown WH: Look up in Appendix K: DHW and Space Heat Fuel Split or default[58] = 0.18	N/A	[276]

[53] Average of lowest typical hot water boiler setting of (120°F) and highest typical setting of (200°F).
[54] Residential boiler's steam temperature shall be the boiling point of water at sea level (212°F).
[55] Nominal gas or oil water heater recovery efficiency taken by CFR is 75% for deriving water energy consumption of consumer products such as dishwashers, etc. [270]
[56] The CFR Uniform Test Method for the measurement of Standby Loss of Electric Storage Water Heaters, electric Storage-Type Instantaneous Water Heaters, and electric Instantaneous Water Heaters (Other Than Storage-Type Instantaneous Water Heaters) uses 98% efficiency for electric water heaters with immersed heating elements. [270]
[57] Also called Building Load Coefficient per unit length.
[58] "Unknown" calculated as the number of homes with electric water heating divided by the total number of homes with water heating in EIA Residential Energy Consumption Survey (RECS) 2015 for Middle Atlantic States, Table HC8.7.

Variable	Description	Value	Units	Ref
SF_{fuel}	Adjustment to fossil fuel water heating energy savings based on water heating fuel	Electric WH: 0 Fossil Fuel WH: 1.0 Unknown WH: Look up in Appendix K: DHW and Space Heat Fuel Split or default[59] = 0.82	N/A	[276]
CF	Electric coincidence factor	Look up in Table 2-189	N/A	
PDF	Gas peak day factor	Look up in Table 2-189	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 2-185 $(UA/L)_{baseline}$

Nominal Pipe Diameter (in)	Bare Copper Piping			Bare Steel Piping	
	Domestic Hot Water	Hot Water Heat	Steam Heat	Hot Water Heat	Steam Heat
0.50	0.44	0.48	0.53	0.53	0.59
0.75	0.54	0.58	0.64	0.65	0.72
1.00	0.65	0.70	0.78	0.79	0.88
1.25	0.80	0.86	0.96	0.97	1.09
1.50	0.90	0.97	1.09	1.10	1.23
2.00	1.10	1.19	1.33	1.34	1.51
2.50	1.31	1.42	1.58	1.60	1.80
3.00	1.57	1.70	1.90	1.92	2.16
3.50	1.77	1.92	2.15	2.18	2.45
4.00	1.98	2.14	2.40	2.43	2.73

Table 2-186 $(UA/L)_q$

Nominal Pipe Diameter (in)	Fiberglass						Rigid Foam/Cellular Glass					
	0.5 in	1 in	1.5 in	2 in	2.5 in	3 in	0.5 in	1 in	1.5 in	2 in	2.5 in	3 in
0.50	0.13	0.09	0.08	0.07	0.06	0.06	0.15	0.12	0.10	0.09	0.09	0.08
0.75	0.14	0.11	0.09	0.08	0.07	0.07	0.17	0.13	0.11	0.10	0.10	0.09

[59] "Unknown" calculated as the number of homes with gas water heating divided by the total number of homes with water heating in EIA Residential Energy Consumption Survey (RECS) 2015 for Middle Atlantic States, Table HC8.7.

Nominal Pipe Diameter (in)	Fiberglass						Rigid Foam/Cellular Glass					
	0.5 in	1 in	1.5 in	2 in	2.5 in	3 in	0.5 in	1 in	1.5 in	2 in	2.5 in	3 in
1.00	0.17	0.12	0.10	0.09	0.08	0.07	0.19	0.15	0.13	0.12	0.11	0.10
1.25	0.20	0.14	0.11	0.10	0.09	0.08	0.23	0.17	0.15	0.13	0.12	0.11
1.50	0.22	0.15	0.12	0.11	0.10	0.09	0.25	0.19	0.16	0.14	0.13	0.12
2.00	0.26	0.18	0.14	0.12	0.11	0.10	0.29	0.22	0.18	0.16	0.14	0.13
2.50	0.30	0.20	0.16	0.14	0.12	0.11	0.34	0.25	0.20	0.18	0.16	0.15
3.00	0.35	0.24	0.18	0.16	0.14	0.12	0.39	0.29	0.23	0.20	0.18	0.16
3.50	0.40	0.26	0.20	0.17	0.15	0.13	0.44	0.32	0.26	0.22	0.20	0.18
4.00	0.44	0.29	0.22	0.18	0.16	0.14	0.48	0.35	0.28	0.24	0.21	0.19

Table 2-187 Et_{fuel} for Space Heating Boilers

Product Class	AFUE (Manufactured before 9/1/2012)	AFUE (Manufactured on/after 9/1/2012, before 1/15/2021)	AFUE (Manufactured on/after 1/15/2021)
Gas-fired hot water boiler	0.80	0.82	0.84
Gas-fired steam boiler	0.75	0.80	0.82
Oil-fired hot water boiler	0.80	0.84	0.86
Oil-fired steam boiler	0.80	0.82	0.85

Table 2-188 Et_{elec} for Domestic Hot Water Heaters

Size (Gallons)	UEF	Et_{elec}
50	3.30	2.83
50	3.50	2.92
50	3.75	3.14
65	3.30	2.85
65	3.50	2.94
65	3.75	3.24
80	3.30	2.85
80	3.50	3.01
80	3.75	3.38

Size (Gallons)	UEF	Et_{elec}
Unknown Size[60]	-	3.016

Peak Factors

Table 2-189 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	DHW: 1.0 Space Heat: N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 2-190 Measure Life

Equipment	EUL	RUL	Ref
Electric Water Heaters	13	4.33	[280]
Gas Water Heaters	11	3.66	[280]

References

[268] 2022 Illinois Statewide Technical Reference Manual for Energy Efficiency. 2021, Page 88. https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_3_Res_09242021.pdf

[269] Pipe Sizing Charts Tables | Energy-Models.com. 2013. Energy-Models.com. 2013. https://energy-models.com/pipe-sizing-charts-tables.

[270] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430 eCFR. December 1, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[271] 2022 California Public Utilities Commission. n.d. Review of DEER Resources - Water Heater - DEER Water Heater Calculator. Cedars - California Energy Data and Reporting System. https://cedars.sound-data.com/deer-resources/tools/water-heaters/.

[272] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter B, Part 430, Appendix E - Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature.

[60] Unknown COP is the average of storage tank heat pump water heater's COP for medium to high draw types covering a storage capacity range of 50 gallons to 80 gallons taken from California Energy Data and Reporting System's DEER Water Heater Calculator [271].

https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B

[273] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 431. Appendix B to Subpart G of Part 431 - Uniform Test Method for the Measurement of Standby Loss of Electric Storage Water Heaters and Storage-Type Instantaneous Water Heaters, eCFR. December 1, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-G

[274] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 9 (New York State Joint Utilities, 2021), Pg 76. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf

[275] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 9. (New York State Joint Utilities, 2021), Pg 74. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf

[276] NREL. 2022. Review of US Residential Sector circa 2018. ResStock. September 2022. https://resstock.nrel.gov/dataviewer/building-characteristics/?datasetName=vizstock_resstock_amy2018_release_2022_1_by_state_view.

[277] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430, Subpart C, 430.32 d) eCFR. November 28, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[278] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[279] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 9. (New York State Joint Utilities, 2021), Pg 509, https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf

[280] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

2.7.9 POOL PUMPS

Market	Residential/Multifamily
Baseline Condition	TOS/NC
Baseline	Code
End Use Subcategory	Swimming Pools
Measure Last Reviewed	December 2022

Description

This measure covers the installation of ENERGY STAR® certified variable frequency drive (VFD) pool pumps in residential buildings and multifamily buildings. An ENERGY STAR® certified pool pump can run at different speeds and be programmed to match the pool operation with its appropriate pool pump speed. The measure is applicable to new construction, or time of sale baseline conditions.

Baseline Case

The baseline case is a self-priming (aboveground) or non-self-priming (inground) pool filter pump with a minimum allowable weighted energy factor defined by the Code of Federal Regulations [281]. Starting July 19, 2021, all pool pumps must be rated according to Weighted Energy Factor (WEF), i.e., kilogallons of water pumped per unit kWh [282].

Efficient Case

The efficient case is an ENERGY STAR® version 3.1 qualified variable-speed self-priming (inground) or non-self-priming (aboveground) pool filter pump. The weighted energy factor of the efficient pump must be greater than or equal to the Energy Star WEF requirement set for a given hydraulic horsepower (HHP) class of pool pumps. The HHP is the overall pumping power that is available from the motor and is different than the shaft power. The HHP can be derived from the proposed ENERGY STAR® pump's spec sheet from the ENERGY STAR® Database [283].

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = units\ x\ days\ x\ V_{pool}\ x\ N_{turnover}\ x\ \left(\frac{1}{WEFb} - \frac{1}{WEFq}\right)/1{,}000$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh\ x\ ETDF$$

Where,

$$ETDF = \frac{CF}{Hrs}$$

$$Hrs = Hrs_{daily}\ x\ days$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 2-191 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Hrs	Annual hours of operation	Calculated	hr	
units	Number of measures installed	Site-specific	N/A	
days	Number of days of operation of the pool pump annually	Site-specific, if unknown use 122	N/A	[284]
V_{pool}	Volume of pool	Site-specific, if unknown use 22,000 gallons (inground) 7,540 (above ground)	Gallons	[285][289]
$N_{turnover}$	Number of turnovers per day, where a turnover is a full cycling of pool water by the pump through the filter or the cleaner	Site-specific, if unknown use 2	N/A	[285]
WEF_b	Minimum allowable Federal Weighted Energy Factors	Look up in Table 2-192	kgal/kWh	[282][283]
WEF_q	Energy Efficient Pool Pumps Weighted Energy factor, per Energy Star certificate	Site-specific, min qualifying in Table 2-192	kgal/kWh	[282][283]

Variable	Description	Value	Units	Ref
HHP	Hydraulic horsepower, per energy star certificate	Site-specific	hp	[283]
Hrs_{daily}	Daily hours of pump operation	Site-specific, if unknown use 5.18	hrs	[286]
CF	Coincidence factor	Look up in Table 2-193	N/A	[287]
PDF	Peak day factor	Look up in Table 2-193	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 2-192 Minimum Allowable WEF Rating

Dedicated-Purpose Pool Pump Type	HHP Applicability	Motor Phase	Baseline WEF Score (kgal/kWh)	Qualifying WEF Score (kgal/kWh)
Self-priming pool filter pumps	0.711 hp ≤hhp <2.5 hp	Single	−2.30 x ln(hhp) + 6.59	-2.45 x ln(hhp) + 8.4
Self-priming pool filter pumps	0.13 hp < hhp <0.711 hp	Single	−1.30 x ln(hhp) + 2.90	-2.45 x ln(hhp) + 8.4
Self-priming pool filter pumps	hhp ≤0.13 hp	Single	5.55	13.4
Non-self-priming pool filter pumps	0.13 hp < hhp < 2.5 hp	Any	−0.85 x ln(hhp) + 2.87	-1.00 x ln(hhp) + 3.85
Non-self-priming pool filter pumps	hhp ≤0.13 hp	Any	4.60	4.92

Peak Factors

Table 2-193 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.27	[287]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years [288].

References

[281] Code of Federal Regulations. Review of Title 10, Chapter II, Subchapter D, Part 431, Subpart Y, 431.465 f). ECFR. September 19, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-Y.

[282] ENERGY STAR® Pool Pump ver 3.1 Final Specification Sheet. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%203.1%20Pool%20Pumps%20Final%20Specification.pdf

[283] ENERGY STAR®, ENERGY STAR® Product Finder. https://www.energystar.gov/productfinder/product/certified-pool-pumps

[284] CEE, Consortium for Energy Efficiency. 2013. Review of CEESM High Efficiency Residential Swimming Pool Initiative. Edited by Eileen Eaton. January 2013. https://library.cee1.org/system/files/library/9986/CEE_Res_SwimmingPoolInitiative_01Jan2013_Corrected.pdf

[285] "Energy Star Pool Pump Calculator | Building America Solution Center." n.d. Basc.pnnl.gov. Accessed December 1, 2022. https://basc.pnnl.gov/library/energy-star-pool-pump-calculator

[286] "Mid-Atlantic Technical Reference Manual (TRM) V10 | Northeast Energy Efficiency Partnerships." n.d. Neep.org. Accessed December 1, 2022. https://neep.org/mid-atlantic-technical-reference-manual-trm-v10

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[288] DEER 2014 EUL ID: OutD-PoolPump

[289] *Evaluation of Potential Best Management Practices – Pools, Spas, and Fountains,* (The California Urban Water Conservation Council, 2010) Pg 3. https://calwep.org/wp-content/uploads/2021/03/Pools-Spas-and-Fountains-PBMP-2010.pdf

2.8 WHOLE BUILDING

2.8.1 BEHAVIORAL CHANGE

Market	Residential/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Category	Whole Building
Measure Last Reviewed	January 2023

Description

This measure covers enrollment in a residential behavioral program that is designed to encourage lower energy usage through behavioral messaging. These behavioral messages can be periodic normative reports or messages that present the customers with timely information on their energy usage and a call to action to reduce or save energy. Behavioral messages can be delivered through many avenues, including paper, email, and text messages.

Because the characteristics of behavioral programs make them amenable to randomized, controlled trials (RCT), and because the program design includes an annual evaluation of its behavioral energy efficiency programs, use of evaluated savings estimates is required for each program year. Evaluations should be conducted, and savings calculated in accordance with the NJ Evaluation Guidelines: Behavioral Program Process and Impact Evaluations, Prepared by NJ Statewide Evaluator (SWE). If the program design changes and an annual evaluation is not conducted, savings as a percent of annual billed consumption from the most recent approved evaluation study must be used. Results from the NJ Triennium 1 Program year 1 evaluations are shown in Table yy.

The measure life for each participating customer is 1 year. Once the customer stops participation, savings may be claimed for the last participating year plus one additional year at the discretion of the program implementer.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

ΔkWh = Savings derived from annual evaluation compliant with Behavioral Guidance Document

Annual Fuel Savings

$\Delta Therms$ = Savings derived from annual evaluation compliant with Behavioral Guidance Document

Peak Demand Savings

ΔkW_{peak} = Savings derived from annual evaluation compliant with Behavioral Guidance Document

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = 0$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 2-194 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated per NJ Behavioral Program Guideline	kWh	[290]
ΔTherm	Annual natural gas savings	Calculated per NJ Behavioral Program Guideline	therms	[290]
ΔkW_{Peak}	Peak Demand Savings	Calculated per NJ Behavioral Program Guideline	kW	[290]
$\Delta Therms_{Peak}$	Daily peak fuel savings	0	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta Therms_{Peak}$	Daily peak fuel savings	0	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
EUL	Effective useful life	See Measure Life Section	yr	[295]

Table 2-195 Annual Savings Percentage from Tri 1 PY1 Evaluations

Percent Savings [291][292][293][294]		
Utility	**Electricity**	**Natural Gas**
PSE&G	0.56%	0.41%
ETG		0.50%
SJG		1.07%
RECO	0.20%	

Measure Life

The measure life for each participating customer is 1 year. Once the customer stops participation, savings can be claimed for the last participating year plus one additional year at the discretion of the program implementer [295].

References

[290] NJ Evaluation Guidelines: Behavioral Program Process and Impact Evaluations, Prepared by NJ Statewide Evaluator (SWE). April 2023.

[291] Cadmus. Public Service Electric & Gas Clean Energy Future Program Year 2021/2022 Evaluation Report, February 3, 2023.

[292] ADM. EM&V Report, Prepared for South Jersey Industries Utility, Elizabethtown Gas, Program Year 1: July 1, 2021 – June 30, 2021. February 21, 2023.

[293] ADM. EM&V Report, Prepared for South Jersey Industries Utility, South Jersey Gas, Program Year 1: July 1, 2021 – June 30, 2021. February 21, 2023.

[294] AEG. Memorandum, PY1 Behavioral Program Evaluation, RECO, January 26, 2023.

[295] NMR "R1606 Eversource Behavior Program Persistence Evaluation." Oct. 15, 2017. https://energizect.com/sites/default/files/documents/R1606_Eversource%20Behavior%20Persistence%20Evaluation_FINAL_10.15.17%20(1).pdf

2.8.2 HOME PERFORMANCE WITH ENERGY STAR (HPWES)

Market	Residential/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Category	Whole Building
Measure Last Reviewed	January 2023

Description

This measure addresses whole building upgrades to residential and multifamily low-rise buildings compliant with the Home Performance with Energy Star (HPwES) version 1.5 requirements [296]. In order to implement Home Performance with ENERGY STAR, there are various standards, a program implementer must adhere to . The HPwES program implemented in NJ uses software that meets national standards for savings calculations from whole-house approaches such as home performance. The difference in modeled annual energy consumption between the program and existing home is the project savings for heating, hot water, cooling, lighting, and appliance end uses.

The software the program implementer uses must adhere to at least one of the following standards:

- A software tool whose performance has passed testing according to the National Renewable Energy Laboratory's HERS BESTEST software energy simulation testing protocol [297].
- Software approved by the US Department of Energy's Weatherization Assistance Program [298].
- RESNET approved rating software [299].

There are numerous software packages that comply with these standards. Some examples of the software packages are SnuggPro[61][300], REM/Rate, EnergyGauge and TREAT.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = From\ Approved\ Software$$

Annual Fuel Savings

$$\Delta Therms = From\ Approved\ Software$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh\ x\ ETDF$$

[61] SnuggPro uses the OptiMiser energy modeling engine

Where,

$$ETDF = 0.0006033$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms\ x\ PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms\ x\ EUL$$

Calculation Parameters

Table 2-196 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated by Approved Software	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated by Approved Software	Therm/yr	
ΔkW_{Peak}	Peak demand savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ETDF	Energy to demand factor	0.0006033	kW/kWh	[301]
PDF	Natural gas peak day factor	See Appendix G: Natural Gas Peak Day Factors	Day/yr	

References

[296] Home Performance with Energy Star (HPwES) version 1.5 requirements Program Requirements | ENERGY STAR

[297] Information about BESTEST-EX can be found at http://www.nrel.gov/buildings/bestest- ex.html

[298] A listing of software approved by US DOE available at https://www.energy.gov/scep/wap/weatherization-energy-audits

[299] A listing of the approved RESNET software available at https://www.resnet.us/providers/accredited-providers/hers-software-tools/

[300] SnuggPro software https://snuggpro.com/

[301] Energy to demand factor vetted by Joint Utility Evaluators and embedded in SnuggPro software

2.8.3 NEW CONSTRUCTION

Market	Residential/Multifamily
Baseline Condition	NC
Baseline	Building Code
End Use Category	Whole Building
Measure Last Reviewed	January 2023

Description

This measure addresses high performance residential and multifamily new building design and construction. High performance new construction projects must satisfy the requirements for ENERGY STAR certification following either the Single-Family New Homes V3.1 program [302] or the Multifamily New Construction V1.1program [303], US DOE Zero Energy Ready Home program [304], Passive House Institute US [305] or Passive House Institute [306].

High performance new construction projects in NJ shall estimate energy savings based on the difference in modeled annual energy consumption between the proposed new building design and a minimally code compliant building of equivalent area. Peak demand savings, if not reported by the software, should be calculated as a function of the energy savings as shown below:

$$kW = kWh \times \frac{CF}{EFLH_{cool}}$$

Where:

CF = cooling coincidence factor from Section 2.3.1

$EFLH_{cool}$= cooling equivalent full load hours from Section 2.3.1

Minimum energy performance requirements for all new construction projects are measured from IECC 2018/2021 or ASHRAE 90.1-2016/2019 energy code baselines, which is dictated by when the project permit was pulled. Modeling software requirements shall be dictated by the selected high performance new construction compliance program (i.e., those listed above). Energy and demand savings for measures included in the program but not modeled by the software should be calculated using the appropriate TRM measure section.

References

[302] Energy Star V3.1 Single Family New Homes requirements
[303] Energy Star V1.1 Multifamily New Construction requirements
[304] DOE Zero Energy Ready Home (ZERH) Program requirements.
[305] Passive House Institute US requirements
[306] Passive House Institute requirements

2.8.4 CUSTOM

Market	Residential
Baseline Condition	TOS/NC/RF/EREP/ERET/DI
Baseline	Code/ISP/Existing/Dual
End Use Category	Custom
Measure Last Reviewed	January 2023

Description

In addition to the typical measures for which savings algorithms have been developed, it is important to identify and address additional opportunities for energy savings. Custom measures can often provide significant energy savings and can be tailored to the specific needs of a project. If necessary, the utilities may develop specific guidelines for frequent custom measures for use in reporting and contractor tracking. This will ensure that the custom measures are implemented correctly and consistently; and that the energy savings are accurately reported. Additionally, it is important to continuously monitor and evaluate the effectiveness of the custom measures implemented and make adjustments as needed.

To implement custom measures, it is necessary to develop individual calculations for each measure to determine the energy savings. These calculations should take into account factors such as the cost of implementation and the expected energy savings. Once the calculations are complete, the project should be reviewed for reasonableness. Before a full review of the project is started, the project package should first be checked for completeness and compliance with program eligibility rules. Once the project review is complete, savings can be reported based on these individual calculations.

Baseline

The project baseline depends on the baseline condition. For time of sale (TOS) and new construction (NC) measures, the baseline is the applicable equipment energy code or standard; or industry standard practice (ISP). For retrofit (RF), early replacement (EREP), early retirement (ER) and direct install (DI) measures, the baseline is the existing equipment. Early replacement and direct install projects replacing functioning equipment must use a dual baseline approach, where the existing equipment defines the first baseline and code or ISP defines the second baseline. In all cases, the baseline should be more efficient than the existing equipment; if the efficiency of the existing equipment exceeds code or ISP, the existing equipment baseline should also be used for the second baseline calculations. When existing functioning equipment is replaced and savings are based on early replacement, documentation of the existing equipment viability should be provided. Such documentation includes a customer affidavit affirming the viability of the equipment to function over its remaining useful life and a video or picture demonstrating the equipment in action.

Industry Standard Practice (ISP) shall take precedence over a code baseline when ISP can be established. Projects not subject to codes or standards shall define and document an ISP baseline as part of the project development package. ISP for specific custom projects can be established through interviews with equipment vendors or subject matter experts.

Efficient Case

The efficiency of the measure shall exceed the first (and if applicable the second) baseline efficiency, and a rationale for how the project saves energy shall be provided.

Energy Savings Algorithm

Energy and demand savings are calculated on a custom basis for each customer's specific situation. Savings are calculated as the difference between baseline energy usage/peak demand and the energy use/peak demand after implementation of the custom measure. Energy savings calculations vary according to the custom project requirements, but generally fall into the following classifications:[62]

Simple Engineering Equations

Custom engineering calculations may be developed to estimate energy savings. These may be presented as a series of simple engineering equations tailored to the custom project measure. The engineering calculations must be documented, and spreadsheets used to calculate the savings must be provided with live calculations. The engineering analysis must be sufficiently documented to allow an independent calculation of the measure savings.

Bin Methods

One method for calculating energy savings for custom energy efficiency measures is through the use of weather based bin analysis. This method involves analyzing weather data and grouping it into "bins" based on temperature, humidity, and other environmental factors. The bin analysis presents the number hours a particular weather condition exists during the year. Note, bin data to not consider time of day; hours tabulated for each weather bin are disconnected in time. Bin analysis is generally not applicable to time dependent measures.

Simulation

Another method for calculating energy savings for custom energy efficiency measures is through the use of whole building energy simulations. This approach involves creating a computer model of a building that takes into account factors such as the building's layout, construction materials, HVAC systems, lighting, and other equipment. The model is then used to simulate different scenarios and analyze the building's energy consumption under different conditions. This can be useful for identifying opportunities for energy savings and for evaluating the potential impact of different custom measures. For example, a whole building simulation can be used to analyze the impact of different insulation materials, HVAC equipment, or window treatments on energy consumption. Whole building modeling simulations can be a powerful tool for identifying and addressing opportunities for energy savings across a package of measures where significant measure interactions are expected.

Pre/Post Billing Analysis

Energy savings may be calculated through an analysis of whole building or submetered energy consumption before and after measure installation. The billing analysis should use a linear or multi-variate regression approach that normalizes the savings for differences in weather conditions during the pre and post periods, and also corrects for energy consumption not related to the measures, such as the addition of photovoltaic systems or electric vehicle chargers. The pre/post billing analysis should follow the International Measurement and Verification Protocol (IPMVP) Option C and/or ASHRAE Guideline 14. Open source software products compliant with IPMVP Option C or ASHRAE Guideline 14 such as

[62] See the California Evaluation Framework [307] Chapters 6 and 7 for more information about engineering methods.

OpenEEMeter are acceptable methods to evaluate energy savings under conditions where the energy consumption data can be fit to outdoor temperature or degree-day data, and savings can be adjusted to account for changes in energy consumption not related to the project.

Pre/Post Billing Analysis approaches are best suited for EREP, ERET and DI projects where an existing equipment baseline is appropriate. Pre/Post Billing Analysis approaches are not suitable for NC and TOS projects. When calculating lifetime savings, EREP, ERET and DI projects must adjust savings from an existing equipment baseline to a code or ISP baseline during the second baseline period.

Calculation Parameters

Energy savings calculations must identify the source of each parameter used in the analysis. Parameters that are uncertain should be identified as candidates for project specific measurement and verification (M&V).

Measurement and Verification

Projects where the input assumptions and savings estimates are uncertain may benefit from site specific measurement and verification (M&V). Project developers and reviewers should consider whether the value savings at risk is sufficient to justify the additional M&V costs. For projects that include M&V, a site specific measurement and verification plan should be developed that documents measurement activities and their use in the energy savings analysis. Depending on the level of uncertainty, M&V may be conducted before measure installation (pre installation M&V) and/or after measure installation (post installation M&V). The International Measurement and Verification Protocol (IPMVP) and/or ASHRAE Guideline 14 should be referenced when developing an M&V plan. The M&V plans may follow IPMVP Option A (partially measured retrofit isolation), Option B (fully measure retrofit isolation) Option C (Whole building billing analysis) or Option D (Calibrated simulation) approaches.

Lifetime Energy Savings Algorithms

Lifetime energy savings for Time of Sale (TOS) and New Construction (NC) projects are calculated as the product of the first year kWh and/or therm savings and the measure effective useful life (EUL). Projects with multiple measures having different EULs shall use a savings weighted average EUL across all measures in the project.

Lifetime savings for early replacement (EREP), early retirement (ERET) and direct installation (DI) measures where functioning equipment is replaced must use a dual baseline approach. The first baseline savings considers the difference between the existing equipment consumption and the measure consumption for the remaining life (RUL) of the existing equipment. The second baseline savings considers the difference between code or standard practice equipment consumption and the measure consumption for the remaining life of the measure (EUL-RUL).

Peak Factors

The summer coincident peak demand savings shall be calculated consistent with the system peak definition presented in Chapter 1.

Measure Life

Measure life will be specific to each custom measure. For custom measures using technologies that are the same or similar to those addressed in other TRM measures, refer to the TRM for measure lives. For measures not covered by the TRM, measure life assumptions shall be documented and justified in the project documentation package. The EUL for retrofit

(RF) measures shall be calculated as the smaller of the measure EUL or the host equipment remaining useful life (RUL). The overall project EUL shall be the savings weighted EUL of the measures included in the project.

References

[307] California Evaluation Framework. Available at https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/utilities_and_industries/energy/energy_programs/demand_side_management/ee_and_energy_savings_assist/caevaluationframework.pdf

[308] International Measurement and Verification Protocol (IPMVP) available at https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

[309] ASHRAE Guideline 14-2014. Available at https://webstore.ansi.org/standards/ashrae/ashraeguideline142014

[310] Linux Foundation, OpenEEMeter https://lfenergy.org/projects/openeemeter/ Accessed 5/18/23.

3 COMMERCIAL & INDUSTRIAL

3.1 AGRICULTURE

3.1.1 AUTO MILKER TAKEOFF

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This section provides energy savings and demand savings algorithms for replacement of manual milker takeoffs with automatic milker takeoffs on dairy milking vacuum pump systems. Automatic milker takeoffs have flow sensors which help shut off the suction on teats once a minimum flow rate is achieved. This reduces the load on the vacuum pump.

Equipment with existing automatic milker takeoffs is not eligible. In addition, the vacuum pump system serving the impacted milking units must be equipped with a variable speed drive (VSD) to qualify for incentives. Without a VSD, little or no savings will be realized.

Baseline Case

Pre-existing manual takeoffs on constant speed dairy milking vacuum pump systems.

Efficient Case

Automatic milker takeoffs. Vacuum pump system serving the impacted milking units must be equipped with a variable speed drive (VSD).

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N_{cows} \times \Delta ESC$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh \times ETDF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-1 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
N_{cows}	Number of cows milked per day	Site specific	Cows	
ΔESC	Annual energy savings per cow	34[63]	kWh/cow	[312][313][314][315]
ETDF	Energy to demand factor	0.00017	kW/kWh	[316]
CF	Electric coincidence factor	Look up in Table 3-2	N/A	
PDF	Gas peak demand factor	Look up in Table 3-2	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

[63] Annual energy savings per cow was calculated based on the following assumptions.

- An average herd size of 102 cows [315]
- Typical dairy vacuum pump size of 10 HP per herd size [316]
- Average pump operating hours are estimated at 10 hours per day [314]
- A 12.5% Energy savings factor [315]

Peak Factors

Table 3-2 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years [311].

References

[311] Idaho Power Demand Side Management Report, Supplement 1. March 15, 2022. https://docs.idahopower.com/pdfs/EnergyEfficiency/Reports/2021%20Supplement%201.pdf

[312] Chuck Nicholson, Mark Stephenson, Andrew Novakovic, *Study to Support Growth and Competitiveness of the Pennsylvania Dairy Industry*, (2017) . https://dairymarkets.org/PA/Growth_and_Competitiveness_Study_DRAFT_Final_Report_June_2018.pdf PA Values were assumed to be similar to NJ Values because of the States' close proximity.

[313] Average dairy vacuum pump size was estimated based on the Minnesota Dairy Project literature.

[314] Mark Mayer, David Kammel, *Dairy Modernization Works for Family Farms* (2008). https://archives.joe.org/joe/2010october/pdf/JOE_v48_5rb7.pdf.

[315] Public Utilities Commission of Pennsylvania, *Technical Reference Manual: Volume 3: Commercial and Industrial Measures (2019),* Pg 298, https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[316] Regional Technical Forum (RTF) as part of the Northwest Power & Conservation Council*, Deemed Measures List. Agricultural: Variable Frequency Drives-Dairy, FY2012, V1.2*. https://rtf.nwcouncil.org/measure/dairy-milking-machines-vacuum-pump

3.1.2 DAIRY PUMP VFD

Market	Commercial
Baseline Condition	NC/RF
Baseline	Code/Existing
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

Milking vacuum systems consume large amounts of electricity on dairy farms. A conventional system runs a vacuum pump motor at full speed and a mechanical vacuum regulator creates an intentional air leak or “bleed” to regulate the system pressure regardless of the amount of milk being pumped. When the system requires a higher level of vacuum, the regulator closes and the vacuum level increases.

This measure modifies the milking vacuum system and installs a variable speed drive (VSD) to control the vacuum pump motor. The VSD controls the speed of the vacuum pump motor, slowing it down when the milking units are attached to the udders, reducing electrical power demand and saving electricity usage. A milking vacuum system controlled with a VSD consists of three main parts: a three ‐ phase electric motor, a VSD unit, and a differential pressure transducer. The VSD modulates the vacuum pump motor speed based on the control signal from the differential pressure transducer. The baseline for this measure reflects a standard vacuum pump motor operating at constant speed. If the motor is being replaced as part of this measure, the “New Motor” efficiency in the Standard Motor Efficiency table below shall be used. Otherwise, the “Existing Motor” efficiency shall be used.

Baseline Case

The baseline condition is a constant speed dairy vacuum pump with a motor size between 2.5-10hp that is controlled with a mechanical vacuum regulator.

Efficient Case

The compliance condition is a dairy vacuum pump with a variable speed drive installed.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left[\left(\frac{hp \times LF \times 0.746}{Eff}\right) - (0.05 \times 2 \times MU + 1.7729)\right] \times hrs$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left[\left(\frac{hp \times LF \times 0.746}{Eff}\right) - (0.05 \times 2 \times MU + 1.7729)\right] \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-3 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
hp	Rated horsepower of vacuum pump motor	Site-specific (limited to 10hp or lesser)	hp	
MU	Number of milking units equipped with a vacuum pump and controlled by VSD	Site-specific, if unknown: 5 hp motor = 3 MU 7.5hp motor = 12 MU 10 hp motor = 22 MU	N/A	
LF	Average load factor for a constant speed vacuum pump	Site-specific, if unknown use 0.76	N/A	[317]
Eff	Rated pump motor efficiency	Site-specific, if unknown look up in Table 3-4	N/A	[318][319]
hrs	Annual hours of pump operation	Site-specific, if unknown use 4,380	hours	[320]
0.746	Conversion factor from kW to hp	0.746	kW/hp	
0.05	Regression coefficient for the average speed of a VSD and processed milk units	0.05	N/A	[323]
2	Air flow rate of milking unit	2	CFM	[323]

Variable	Description	Value	Units	Ref
1.7729	Regression constant for the average speed of a VSD and processed milk units	1.7729	N/A	[323]
CF	Electric coincidence factor	Look up in Table 3-5	N/A	
PDF	Gas peak demand factor	Look up in Table 3-5	N/A	
EUL	Effective useful life	See Measure Life	Years	

Table 3-4 Standard Motor Efficiency

Motor Classification	Size (hp)	Existing Motor	New Motor
Milk: Vacuum Pump with Adjustable Speed Drive Package – 5 HP	5	87.5%	89.5%
Milk: Vacuum Pump with Adjustable Speed Drive Package – 7.5 HP	7.5	88.5%	91.7%
Milk: Vacuum Pump with Adjustable Speed Drive Package – 10 HP	10	89.5%	91.7%

Peak Factors

Table 3-5 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.4	[321]
Natural gas peak day factor (PDF)	N/A	

Measure Life

Table 3-6 Measure Life

Equipment	EUL	RUL	Ref
Dairy Pump VFD	15	5	[322]

References

[317] Cascade Energy. "Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors." Table 6: Load Factor by Nameplate hp and End Use. November 5, 2012. https://nwcouncil.app.box.com/s/fkxkcwm1is88dnttb8ve7eb5rhs9qhmv

[318] The Energy Independence and Security Act of 2007 (EISA), 1800 RPM, TEFC assumed as typical for Dairy vacuum pump motors, see https://www.govinfo.gov/content/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf

[319] US Department of Energy, Office of Energy Efficiency & Renewable Energy, "Premium Efficiency Motor Selection and Application Guide: A Handbook for Industry". Table 2-1. 1800 RPM, TEFC assumed as typical for

Dairy vacuum pump motors, https://www.energy.gov/sites/prod/files/2014/04/f15/amo_motors_handbook_web.pdf

[320] Assuming 2 milking and cleaning sessions per day, 5 hours per milking session, 1 hour per cleaning session, and 365 days of milking per year.

[321] Regional Technical Forum (RTF) as part of the Northwest Power & Conservation Council, Deemed Measures List. Agricultural: Variable Frequency Drives-Dairy, FY2012, V1.2. https://rtf.nwcouncil.org/measure/dairy-milking-machines-vacuum-pump/

[322] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

[323] Sanford, Scott (University of Wisconsin–Madison). "Milking System Air Consumption When Using a Variable Speed Vacuum Pump", Figure 2. The regression coefficient of 0.0018 LPM is converted into 0.05 CFM. An air leakage rate of 2 CFM is chosen as a conservative estimate for which to perform regression analysis.

3.1.3 DAIRY REFRIGERATION TUNE UP

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Maintenance
Measure Last Reviewed	January 2023

Description

This section provides energy savings and demand savings algorithms for tune-ups on all refrigeration equipment in commercial-grade dairy settings with the intention being to reduce electrical consumption.

Baseline Case

Refrigeration equipment associated with a commercial-grade dairy farm facility that has not been inspected or tuned up in more than 12 months.

Efficient Case

The efficient condition is refrigeration equipment associated with a commercial-grade dairy farm facility that has been inspected and tuned up by a U.S. EPA 608 Certified Service Provider. The certified technician must abide by all rules and regulations related to refrigerant testing and safety protocol and must conduct the following tasks:

- Clean and inspect condenser and evaporator coils;
- Clean drain pan;
- Inspect/clean fans, screens, grills, filters, and drier cores;
- Inspect/adjust heat reclaim operation;
- Tighten all line voltage connections;
- Inspect/replace relays and capacitors as needed; and
- Add/remove refrigerant charge as needed.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{N_{cows} \times lbs_{milk} \times C_{p,milk} \times \Delta T}{AEER \times 1{,}000} \times SF$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \mathrm{N/A}$$

Calculation Parameters

Table 3-7 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
N_{cows}	Number of cows	Site-specific	N/A	
lbs_{milk}	Average pounds of milk produced per cow per year	Site-specific, if unknown use 19,800	Lbs/yr	[324]
$C_{p,milk}$	Specific heating capacity of milk	0.93	Btu/lb-°F	[325]
ΔT	Difference in temperature between milk entering the bulk tank and final stored temperature of cooled milk	Look up in Table 3-8	°F	[326][327]
SF	Energy savings factor	0.05	N/A	[328]
AEER	Annual energy efficiency ratio of refrigeration compressor	15.39	Btu/watt-hr	[327]
1,000	Conversion from watts to kilowatts	1,000	W/kW	
CF	Electric coincidence factor	Look up in Table 3-9	N/A	
PDF	Gas peak demand factor	Look up in Table 3-9	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-8 Milk Temperature Differential (°F)

Type of cooling	Temperature (°F)
No pre-cooler used in operation	60
Pre-cooler used	30
Pre-cooler unit and VFD Pump are used	18.3

Peak Factors

Table 3-9 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 1 year [327].

References

[324] New Jersey Dept of Agriculture, 2021 Annual Report and Agricultural Statistics. (2021), page 21. https://www.nass.usda.gov/Statistics_by_State/New_Jersey/Publications/Annual_Statistical_Bulletin/2021/2021AnnualReportFinal.pdf

[325] 2018 ASHRAE Handbook – Refrigeration, Specific heat of whole milk, Table 3: Unfrozen Composition Data, Initial Freezing Point, and Specific Heat of Foods.

[326] Scott Sanford, *Well water precoolers.* (Energy Conservation in Agriculture,2003), Pg 1, https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3784-03.pdf

[327] Sanford, Scott (University of Wisconsin–Madison). "Well Water Precoolers." Publication A3784-3. October 2003. http://learningstore.uwex.edu/Assets/pdfs/A3784-03.pdf

[328] *Best Management Practices for Dairy Farms* (Massachusetts Farm Energy Program, 2012), Pg 30, https://massfarmenergy.com/wp-content/uploads/2014/03/Dairy%20Farms%20Best%20Practices.pdf

3.1.4 DAIRY SCROLL COMPRESSOR

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure covers the replacement of reciprocating compressors with scroll compressors in milk cooling dairy farm applications. A scroll compressor is a device used to compress refrigerant and is more efficient and reliable than traditional reciprocating compressors. Scroll compressors are now the predominant compressor type sold on the market in these applications; therefore, this measure is only applicable in retrofit scenarios. Lifecycle savings are calculated through the end of the remaining life of the existing compressor.

Baseline Case

The baseline condition for this measure is a dairy operation using a reciprocating compressor for milk cooling.

Efficient Case

The compliance condition is the replacement of a reciprocating compressor with a scroll compressor for milk cooling.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{Btu/h_q}{Btu/h_{total}} \times lbs_{milk} \times cows \times \Delta T \times 0.93 \times \left[\left(\frac{1}{EER_b \times 1{,}000}\right) - \left(\frac{1}{EER_q \times 1{,}000}\right)\right]$$

Where,

$$EER_q = \frac{Btu/h_q}{W_q}$$

$$EER_b = \frac{Btu/h_b}{W_b}$$

If EER_b is unknown use

$$EER_b = 0.85 \times EER_q$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{8{,}760} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-10 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Btu/h_q	Nameplate Btu/h of installed scroll compressor	Site-specific	Btu/h	
Btu/h_{total}	Total cooling capacity of compressors on dairy farm	Site-specific	Btu/h	
Btu/h_b	Nameplate Btu/h of existing recip compressor	Site-specific	Btu/h	
lbs_{milk}	Average pounds of milk produced per cow per year	19,800	lb	[329]
cows	Number of milking cows on farm	Site-specific	N/A	
ΔT	Difference in temperature between the milk entering the bulk tank and final stored temperature of cooled milk	Look up in Table 3-11	(°F)	[330]
W_b	Nameplate wattage of existing reciprocating compressor	Site-specific	watts	

Variable	Description	Value	Units	Ref
W_q	Nameplate wattage of installed scroll compressor	Site-specific	watts	
EER_q	Energy efficiency ratio of scroll compressor based on nameplate Btu/h and wattage	Calculated	$\frac{Btu/h}{watts}$	[331]
EER_b	Energy efficiency ratio of reciprocating compressor based on nameplate Btu/h and wattage	Calculated	$\frac{Btu/h}{watts}$	[331]
0.93	Specific heat of milk	0.93	Btu/lb-°F	[332]
1,000	Conversion Factor kW to watts	1,000	Kw/watts	
8,760	Hours in one year	8,760	hours	
CF	Electric coincidence factor	Look up in Table 3-12	N/A	
PDF	Gas peak day factor	Look up in Table 3-12	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-11 Difference in temperature for various equipments

Equipment	ΔT
No Pre-Cooler	60
Standard Pre-Cooler	30
Variable Speed Pre-Cooler	18.3

Peak Factors

Table 3-12 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is limited to the Remaining Useful Life (RUL) of the existing compressor with a default value of 4 years.

References

[329] USDA, National Agricultural Statistics Service, *2021 Annual Report and Agricultural Statistics*, pg. 21. https://www.nass.usda.gov/Statistics_by_State/New_Jersey/Publications/Annual_Statistical_Bulletin/2021/2021AnnualReportFinal.pdf

[330] Sanford, Scott (University of Wisconsin–Madison). *Energy Efficiency for Dairy Enterprises*. Presentation to Agricultural and Life Sciences Program staff. It was determined that a plate cooler alone can reduce milk temperature to 68 ˚F and a plate cooler paired with a milk transfer pump VSD can reduce milk temperature to 56.3 ˚F. The additional benefits of the milk transfer pump VSD over the plate cooler is 11.7 ˚F. Milk is stored at 38°F, therefore 56.3°F-38°F=18.3°F. December 2014. https://aeeibse.wp.prod.es.cloud.vt.edu/wp-content/uploads/2018/01/EC-for-Dairy-Enterprises-Nov-2017.pdf

[331] *Massachusetts Farm Energy Best Management Practices for Dairy Farms*, United States Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS), 2012. https://massfarmenergy.com/wp-content/uploads/2014/03/Dairy%20Farms%20Best%20Practices.pdf

[332] 2018 ASHRAE Handbook – Refrigeration, Specific heat of whole milk, Table 3: Unfrozen Composition Data, Initial Freezing Point, and Specific Heat of Foods.

3.1.5 LIVESTOCK WATERER

Market	Commercial
Baseline Condition	EREP/TOS/NC
Baseline	Existing/ISP/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of energy-efficient livestock waterers. A livestock waterer provides clean drinking water for livestock. Regular livestock waterers employ the use of large electric resistance heaters to prevent water from freezing. Energy efficient livestock waterers use super insulation (insulation of at least 2 inches) to maintain water temperature above freezing temperature.

Baseline Case

Early replacement (EREP) of an existing livestock waterer: First baseline, for remaining useful life of existing equipment: Electrically heated livestock waterer with no insulation. Second baseline, for remainder of measure life: Industry standard practice (ISP).

Time of sale (TOS) of an existing livestock waterer: Industry standard practice (ISP).

Addition of a new (NC) livestock waterer: Industry standard practice (ISP).

Efficient Case

Energy efficient livestock watering system that is thermostatically controlled and has factory-installed insulation with a minimum thickness of 2 inches.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{W_b - W_q}{1{,}000} \times hrs \times F_{runtime}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-13 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
W_b	Rated wattage of baseline livestock waterer heating element	Site-specific. If unknown: Existing: 1,100W ISP: 500W	Watts	[333]
W_q	Rated wattage of efficient livestock waterer heating element	Site-specific	Watts	
hrs	Annual hours of operation during the winter when temperature is below 32°F	Site-specific. If unknown, look up in Table 3-14	hrs	[334]
$F_{runtime}$	Fraction of heater runtime	0.8	N/A	[335]
CF	Electric coincidence factor	Look up in Table 3-15	N/A	
PDF	Gas peak day factor	Look up in Table 3-15	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-14 Annual operating hours

Climate Zone	Hours below 32°F
Northern	1337
Southwest	1220
Coastal	583
Central	1,069
Pine Barrens	1,021
Statewide Average	1,048

Peak Factors

Table 3-15 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	[337]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years [336]. For early replacement projects, if the remaining useful life (RUL) of the existing equipment is unknown, assume 1/3 of the EUL = 3.3 years.

References

[333] *New York Standard for Estimating Energy Savings from Energy Efficiency Programs Version 10*. (New York State Joint Utilities, 2021), pg 385.

[334] Based on TMY3 data for various climate zones in New Jersey.

[335] The Regional Technical Forum (RTF) analyzed metered data from three baseline livestock waterers and found the average run time of electric resistance heaters in the waterers to be approximately 80% for average monthly temperatures similar to Pennsylvania climate zones. This run time factor accounts for warmer make-up water being introduced to the tank as livestock drinking occurs. *Dairy Milking Machines Vacuum Pump Variable Frequency Drive.* n.d. Rtf.nwcouncil.org. Accessed January 13, 2023. https://rtf.nwcouncil.org/measure/dairy-milking-machines-vacuum-pump/

[336] State of Wisconsin, *Focus on Energy Evaluation, Business Program: Measure Life Study Final Report*: *Appendix B* (August 25, 2009). https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

[337] No demand savings are expected for this measure, as the energy savings occur during the winter months.

3.1.6 LOW PRESSURE IRRIGATION

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This section provides energy and demand savings algorithms for the installation of a low-pressure irrigation system, which reduces the amount of energy required to apply the same amount of water as a baseline system.

The amount of energy saved per acre is a factor of the number of nozzles, the amount of water applied, the actual reduction in operating pressure, the pumping plant efficiency, and sprinkler or micro irrigation system conversions made to the system.

This measure requires a minimum 50% decrease in irrigation pumping pressure through the installation of a low-pressure irrigation system in agriculture applications. Pressure reduction can be achieved in several ways, such as nozzle or valve replacement, sprinkler head replacement, alterations or retrofits to the pumping plant, or drip irrigation system installation. Pre and post retrofit pump pressure measurements are required.

Baseline Case

High-pressure irrigation system with a baseline pump pressure, must be measured and recorded prior to installing low-pressure irrigation equipment.

Efficient Case

Low-pressure irrigation system in agriculture applications with a minimum of 50% reduction in pumping pressure.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{\{N_{acres} \times (PSI_b - PSI_q) \times GPM\}}{1{,}714 \times Eff_{motor}} \times \left(\frac{0.746\ kW}{HP}\right) \times HRS$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh \times ETDF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-16 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
N_{acres}	Number of acres irrigated	Site-specific	Acres	
PSI_b	Baseline pump pressure, must be measured and recorded prior to installing low-pressure irrigation equipment	Site-specific	Pounds per square inch (psi)	
PSI_q	Installed pump pressure, must be measured and recorded after the installation of low-pressure irrigation equipment by the installer	Site-specific	Pounds per square inch (psi)	
GPM	Pump flow rate per acre	Site-specific	Gallons Per Minute (GPM) /acre	
HRS	Average irrigation hours per growing season	Site-specific	Hours	
Eff_{motor}	Pump motor efficiency	Site-specific, if unknown look up in Table 3-17	N/A	[338]
0.746	Conversion from kW to HP	0.746	kW/HP	
1,714	Constant used to calculate hydraulic horsepower for conversion between horsepower and pressure and flow	1,714	$PSI \times GPM/HP$	

Variable	Description	Value	Units	Ref
EDTF	Energy to Demand Factor	0.0026	kW/kWh	[340] [341]
CF	Electric coincidence factor	Look up in Table 3-18	N/A	
PDF	Gas peak demand factor	Look up in Table 3-18	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-17 Motor Baseline Efficiencies

Motor HP	Motor Nominal Full-Load Efficiencies (percent)					
	4 Pole (1800 RPM)		6 Pole (1200 RPM)		8 Pole (900 RPM)	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1	85.5	85.5	82.5	82.5	75.5	75.5
1.5	86.5	86.5	87.5	86.5	78.5	77.0
2	86.5	86.5	88.5	87.5	84.0	86.5
3	89.5	89.5	89.5	88.5	85.5	87.5
5	89.5	89.5	89.5	89.5	86.5	88.5
7.5	91.7	91.0	91.0	90.2	86.5	89.5
10	91.7	91.7	91.0	91.7	89.5	90.2
15	92.4	93.0	91.7	91.7	89.5	90.2
20	93.0	93.0	91.7	92.4	90.2	91.0
25	93.6	93.6	93.0	93.0	90.2	91.0
30	93.6	94.1	93.0	93.6	91.7	91.7
40	94.1	94.1	94.1	94.1	91.7	91.7
50	94.5	94.5	94.1	94.1	92.4	92.4
60	95.0	95.0	94.5	94.5	92.4	93.0
75	95.4	95.0	94.5	94.5	93.6	94.1
100	95.4	95.4	95.0	95.0	93.6	94.1
125	95.4	95.4	95.0	95.0	94.1	94.1
150	95.8	95.8	95.8	95.4	94.1	94.1
200	96.2	95.8	95.8	95.4	94.5	94.1

Peak Factors

Table 3-18 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 5 years [339].

References

[338] *Energy Conservation Program: Energy Conservation Standards for Commercial and Industrial Electric Motors; Final Rule: 79 Federal Register 103* (2014) https://www.gpo.gov/fdsys/pkg/FR-2014-05-29/html/2014-11201.htm

[339] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx Accessed January 2023.

[340] Kanagy, Pamela K., *Farm and Ranch Irrigation*. Pennsylvania Agricultural Statistics, 2009-2010. https://www.nass.usda.gov/Statistics_by_State/Pennsylvania/Publications/Annual_Statistical_Bulletin/2009_2010/fris.pdf. Accessed January 2023.

[341] Irrigation Water Withdrawals, 2015 by the U.S. Geological Society. Table 7. https://pubs.usgs.gov/circ/1441/circ1441.pdf. Accessed January 2023.

3.1.7 VENTILATION FANS

Market	Commercial
Baseline Condition	TOS/NC/EREP
Baseline	Existing/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure is applicable to the installation of high speed, high efficiency fans and high-volume low speed (HVLS) fans installed in agricultural applications. For the purposes of this measure, a high speed fan shall consist of the blade and motor assembly. Ventilation, exhaust and circulating high speed fans improve animal comfort, control moisture and maintain indoor air quality for livestock and other agricultural applications. Variable frequency drives (VFD) may be installed along with high speed fans to increase energy savings and the associated savings are quantified by this methodology. If VFD savings are claimed via this measure, additional savings may not be claimed for VFDs utilizing a separate methodology. Qualifying fans must be rated by an Air Movement and Control Association (AMCA) accredited laboratory such as Bioenvironmental and Structural Systems (BESS) Laboratories.[64]

Baseline Case

The baseline condition for this measure is a standard efficiency exhaust, ventilation or circulating fan.

Efficient Case

The compliance condition for this measure is a high speed exhaust, ventilation, circulating, of HVLS fan that meets or exceeds the minimum efficiency requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Exhaust and Ventilation Fans:

$$\Delta kWh = \left(\frac{\frac{CFM_b}{(CFM/W)_b} - \frac{CFM_q}{(CFM/W)_q} \times F_{VFD,q}}{1{,}000} \right) \times hrs$$

Internal circulation fans and HVLS fans:

[64] BESS Laboratories is a research, product testing, and educational laboratory at the University of Illinois.

$$\Delta kWh = \left(\frac{lbf_b}{(lbf/kW)_b} - \frac{lbf_q}{(lbf/kW)_q} \times F_{VFD,q} \right) \times hrs$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-19 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	

Variable	Description	Value	Units	Ref
CFM_b	Cubic feet per minute of existing fan	Site-specific[65], if unknown use CFM_q	Ft^3/min	[345]
CFM_q	Cubic feet per minute of installed fan	Site specific	Ft^3/min	
$(CFM/W)_q$	Ventilating efficiency ratio of installed fan	Site-specific, if unknown look up in Table 3-20	CFM/W	
$(lbf/kW)_q$	Thrust efficiency ratio of installed fan	Site-specific, if unknown look up in Table 3-20	Lbf/kW	
$(CFM/W)_b$	Ventilating efficiency ratio of existing fan	Look up in Table 3-20	CFM/W	
$(lbf/kW)_b$	Thrust efficiency ratio of existing fan	Look up in Table 3-20	Lbf/kW	
lbf_b	Thrust of existing fan	Site specific[66], if unknown use lbf_q	Lbs/force	[345]
lbf_q	Thrust of installed fan	Site-specific	Lbs/force	
$F_{VFD,q}$	Reduced consumption resultant from VFD control	Look up in Table 3-21	N/A	[343]
Hrs	Operating hours	Look up in Table 3-22	Hours	
CF	Electric coincidence factor	Look up in Table 3-23	N/A	
PDF	Gas peak demand factor	Look up in Table 3-23	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-20 Baseline and Efficient Condition Efficiencies

Fan Diameter	Baseline [67]		Efficient[68]	
	Circulation, Ventilation and Exhaust Fans (CFM/W)	Circulating Fans (lbf/kW)	Circulation, Ventilation and Exhaust Fans (CFM/W)	Circulating Fans (lbf/kW)
24”-35”	9.4	10.5	14.0	15.0
36”-47”	12.2	12.9	17.0	20.0
48”-52”	15.1	19.8	19.9	24.2
53”+	16.7	20.8	22.0	24.6

[65] look up from BESS Labs database based on manufacturer and model number.
[66] look up from BESS Labs database based on manufacturer and model number.
[67] Default baseline efficiency was determined by calculating the 10th percentile of the efficiencies of all fans in the active BESS Labs database for the respective fan diameter ranges. Many low efficiency fans are often not tested by BESS Labs, therefore the average tested fan is more efficient than the average market available fan. Ventilation and exhaust fan CFM and circulating fan lbf represent the averages of each diameter range, regardless of fan efficiency. The database includes single and three phase fans at four voltages.
[68] Minimum qualifying fan efficiency is equivalent to the 75th percentile of all BESS Labs tested in the respective fan diameters. The database includes single and three phase fans at four voltages

Table 3-21 VFD Factor

Fan Application	Value
No VFD	1.00
Greenhouse	0.64
Poultry/Livestock	0.75

Table 3-22 Operating Hours

City	Circulating/HVLS Fan Hours[69]	Exhaust/Ventilation Fan Hours[70]
Northern	4,362	6,570
Southwest	4,632	6,570
Coastal	5,017	6,570
Central	4,636	6,570
Pine Barrens	4,684	6,570
Statewide Average	4,655	6,570

Peak Factors

Table 3-23 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	[344]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-24 Measure Life

Equipment	EUL	RUL	Ref
Ventialtion Fans	15	5	[342]

[69] Default hours are developed from NOAA hourly normals by summing annual hours dry bulb temperature above 50ºF; NOAA National Centers for Environmental information – NCEI 2010 Hourly Normals

[70] Exhaust/Ventilation fans are assumed to operate 75% of total annual hours (8,760 x 0.75 = 6,570)

References

[342] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

[343] Teitel, M. & Levi, Asher & Zhao, Yun & Barak, Moti & Bar-lev, Eli & Shmuel, David. (2008). Energy saving in agricultural buildings through fan motor control by variable frequency drives. Energy and Buildings. 40. 953-960. 10.1016/j.enbuild.2007.07.010

[344] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multifamily, and Commercial/Industrial Measures. January 1, 2023.

[345] Circulating Fans, Bioenvironmental and Structural Systems Laboratory, University of Illinois, Department of Agricultural and Biological Engineering, Accessed January 12, 2023. Available from: http://bess.illinois.edu/

3.1.8 HEAT RECLAIMERS

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of a refrigeration heat recovery (RHR) system on bulk tank compressors on dairy farms. Heat recovery systems recover waste heat from bulk tank compressors used in milk cooling processes. This waste heat is used to pre-heat water before it is transferred to a water heater, thus reducing the load of the water heater. Hot water is used in various farm applications such as cleaning and livestock watering.

There are two methods of calculating savings. One is to calculate the amount of energy that can be recovered by the heat recovery system in the milk cooling process. This method is reflected in the ΔBTU_{milk} equation. The second method is to calculate the energy required to heat the water in the storage tank to the set point. This method is reflected in the ΔBTU_{hru}, equation. The smaller of the two shall be selected. If ΔBTU_{milk} is smaller than ΔBTU_{hru}, this implies that the energy recovered by the heat recovery system is not sufficient to fully heat the water to the setpoint, and therefore represents the upper limit of savings. If ΔBTU_{hru} is smaller than ΔBTU_{milk} this implies the energy required to heat the water to the setpoint is less than the energy that is recovered by the heat recovery system, and therefore represents the upper limit of savings.

Baseline Case

Baseline condition for this measure is a dairy farm without a heat recovery system to feed preheated water to the water heater.

Efficient Case

The efficient condition is a dairy farm with a heat recovery system to preheat water to the waterheater.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{MIN[\Delta \mathrm{BTU}_{\mathrm{milk}}\ or\ \Delta \mathrm{BTU}_{\mathrm{hru}}]}{3{,}412 \times E_{t,elec}}$$

Where,

$$\Delta BTU_{milk} = lbs_{milk} \times cows \times \Delta T_{milk} \times 0.93 \times ESF$$

$$\Delta BTU_{hru} = v_{hru} \times \Delta T_{water} \times 8.33 \times 365 \times cows$$

$$\Delta T_{water} = T_{set} - T_{main}$$

Annual Fuel Savings

$$\Delta Therms = \frac{MIN[\Delta BTU_{milk} \text{ } or \text{ } \Delta BTU_{hru}]}{100{,}000 \times E_{t,fuel}}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-25 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔBTU_{milk}	Recoverable energy from milk cooling process	Calculated	Btu	
ΔBTU_{hru}	Required energy to heat water in the storage tank unit to set temperature	Calculated	Btu	
ΔT_{water}	Change in water temperature attributable to heat recovery system	Calculated	°F	
Lbs_{milk}	Average pounds of milk produced per cow per year	19,800	Lbs/yr	[346]
Cows	Average number of cows milked per day	Site-specific	cow/day	

Variable	Description	Value	Units	Ref
ΔT_{milk}	Difference in temperature between milk entering the bulk tank and final stored temperature of cooled milk	Look up in Table 3-26	°F	[348]
ESF	Energy Savings Factor	0.4	N/A	[349]
V_{hru}	Volume of hot water for washing and cleaning per day per cow, in gallons	Site specific, if unknown use 6.3gal/cow/day	Gal/cow/day	[350]
T_{set}	Expected temperature an RHR unit can pre-heat well water up to	Site-specific, if unknown look up in Table 3-27	°F	[349]
T_{main}	Water main inlet temperature	Look up in Table 3-28	°F	[351]
$E_{t,elec}$	Thermal efficiency of electric water heater	Site-specific, if unknown use 0.98	N/A	[353]
$E_{t,fuel}$	Thermal efficiency of fossil fuel water heater	Site-specific, if unknown use 0.8	N/A	[354]
Hrs	Hours per year	Site-specific, if unknown use 2,920	Hrs/yr	[352]
0.93	Specific heat of milk	0.93	BTU/lb °F	[355]
8.33	Energy required to heat one gallon of water by one degree	8.33	BTU	
3,412	Conversion factor BTU to kWh	3,412	BTU/kWh	
100,000	Conversion factor BTUs to Therms	100,000	BTU/Therm	
CF	Electric coincidence factor	Look up in Table 3-29	N/A	
PDF	Gas peak day factor	Look up in Table 3-29	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-26 Difference in Milk Temperature (ΔT_{milk} °F)

No Pre-Cooler	Standard Pre-Cooler	Variable Speed Pre-Cooler
60 °F	30 °F	18.3 °F

Table 3-27 RHR Setpoint Temperature (T_{set})

Fully condensing RHR system	Desuperheater RHR condenser
130 °F	105 °F

Table 3-28 Cold Water Inlet Temperature (T_{main})

NJ Climate Region	Annual Average Outdoor Temperature (°F)	T_{main} (°F)
Northern	50.75	56.75
Southwest	52.37	58.37
Coastal	54.29	60.29
Central	52.45	58.45
Pine Barrens	52.44	58.44
Statewide Average	52.45	58.45

Peak Factors

Table 3-29 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	N/A
Natural gas peak day factor (PDF)	See	

Measure Life

The effective useful life (EUL) is 14 years. [346]

References

[346] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

[347] New Jersey Dept of Agriculture, *2021 Annual Report and Agricultural Statistics.* (2021), page 21. 2021AnnualReportFinal.pdf (usda.gov)

[348] Sanford, Scott (University of Wisconsin–Madison). “Well Water Precoolers.” Publication A37843. October 2003. It was determined that a plate cooler alone can reduce milk temperature to 68 ˚F and a plate cooler paired with a milk transfer pump VSD can reduce milk temperature to 56.3 ˚F. The additional benefits of the milk transfer pump VSD over the plate cooler is 11.7 ˚F. Milk is stored at 38°F, therefore 56.3°F-38°F=18.3°F.

[349] DeLaval. “Dairy Farm Energy Efficiency”. (April 20, 2011.) A heat recovery system can recover 20%-60% of the energy required in the milk cooling process.

[350] “Water Use on Dairy Farms.” 2011. MSU Extension. 2011 https://www.canr.msu.edu/news/water_use_on_dairy_farms.

[351] Burch, Jay, and Craig Christensen. n.d. “TOWARDS DEVELOPMENT of an ALGORITHM for MAINS WATER TEMPERATURE.” https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/AlgorithmForMainsWaterTemperature.pdf.

[352] "Dairy Farm Energy Management Guide: California." n.d. Www.energy.wsu.edu. Accessed January 12, 2023. https://www.energy.wsu.edu/EnergyLibrary/AgricultureMatters/CatalogItemDetail.aspx?id=429.

[353] 10 CFR 430 Subpart B Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters: *6.3.2 Recovery Efficiency.* https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B#p-Appendix-E-to-Subpart-B-of-Part-430(6.)(6.3)(6.3.2).

[354] 10 CFR 431.110 (a) – Energy conservation standards and their effective dates. https://www.ecfr.gov/current/title-10/chapter-II/subcharpter-D/part431/subpart-G/

[355] 2018 ASHRAE Handbook – Refrigeration, Specific heat of whole milk, Table 3: Unfrozen Composition Data, Initial Freezing Point, and Specific Heat of Foods.

3.1.9 ENGINE BLOCK HEATER TIMER

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This section provides energy savings algorithms for the installation of timers used to control engine block heaters on existing farm equipment. Engine block heaters are generally used during cold weather to warm an engine prior to use. Block heaters without automation are typicially plugged in throughout the night. Using timers allows the heater to come on at a preset time rather than being on throughout the night. There are no peak demand savings associated with this measure since it does not affect peak period usage.

Baseline Case

Engine block heater without a timer that is manually controlled.

Efficient Case

Engine block heater controlled by a timer.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{W_{heater}}{1{,}000} \times (hrs_b - hrs_q) \times Days \times UF$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-30 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
W_{heater}	Wattage of engine block heater	Site-specific, if unknown use 1,000	W	[358]
hrs_b	Baseline hours of use per day	Site-specific, if unknown use 10	Hrs/day	[358]
hrs_q	Energy efficient hours of use per day	Site-specific, if unknown use 2	Hrs/day	[358]
Days	Days of use per year	Site-specific, if unknown use 90	Days/yr	[358]
UF	Usage Factor	Site-specific, if unknown use 0.97	N/A	[356]
CF	Electric coincidence factor	Look up in Table 3-31	N/A	
PDF	Gas peak demand factor	Look up in Table 3-31	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 3-31 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 15 years [357].

References

[356] Wisconsin Focus on Energy 2018 Technical Reference Manual. Public Service Commission of Wisconsin. The Cadmus Group, Inc. 2018. Pg. 590. https://www.focusonenergy.com/sites/default/files/TRM%202018%20Final%20Version%20Dec%202017_1.pdf

[357] Gutierrez, Alfredo. Circulating Block Heater. Prepared for the California Technical Forum. http://static1.squarespace.com/static/53c96e16e4b003bdba4f4fee/t/556f7c9ee4b0b65c3515c80c/1433369758093/Circulating+Block+Heater+Presentation_ver+2.pdf

[358] 2018 Wisconsin Association of FFA to Farm Engine Block Heater Timer Fundraiser Fact Sheet. https://s3.us-east-1.amazonaws.com/focusonenergy/staging/inline-files/EBHT_Trifold_2018_1.pdf

3.2 APPLIANCES

3.2.1 CLOTHES WASHER

Market	Commercial/Multifamily
Baseline Condition	TOS/NC
Baseline	Code
End Use Subcategory	Clothes Washer
Measure Last Reviewed	January 2023

Description

This measure relates to the purchase (time of sale) and installation of a commercial clothes washer (i.e., soft-mounted front-loading or soft-mounted top-loading clothes washer that is designed for use in applications in which the occupants of more than one household will be using the clothes washer, such as multifamily housing common areas and coin laundries) exceeding the ENERGY STAR minimum qualifying efficiency standards. The Modified Energy Factor (MEF) measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency. The Water Factor (WF) is the number of gallons needed for each cubic foot of laundry. A lower number indicates lower consumption and more efficient use of water. Rather than filling the tub with water, efficient wash cycles are achieved by spinning or flipping clothes through a stream of water. Efficient rinse cycles are achieved through high-pressure spraying instead of soaking clothes. Reduced dryer load represents additional energy savings associated with the thorough removal of water from the clothes in the washer. Clothes washers that have earned the ENERGY STAR® label use approximately 25% less energy and 33% less water than comparable non-qualified models.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline efficiency is minimum efficiency defined in the Code of Federal Regulations at 10 CFR 431.156. Efficiency is defined by the Modified Energy Factor (MEF) that takes into account the energy and water required per clothes washer cycle, including energy required by the clothes dryer per clothes washer cycle.

Efficient Case

The efficient condition is a commercial clothes washer meeting the ENERGY STAR v. 8.1 efficiency criteria.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{washer} + \Delta kWh_{DHW} + \Delta kWh_{dryer}$$

Where,

$$\Delta kWh_{washer} = \Delta kWh_{unit} \times F_{washer}$$

$$\Delta kWh_{DHW} = \Delta kWh_{unit} \times F_{DHW} \times SF_{DHW,electric}$$

$$\Delta kWh_{dryer} = (\Delta kWh_{total} - \Delta kWh_{unit}) \times \frac{F_{loads}}{F_{dryer}} \times F_{dryer,mod} \times SF_{dryer,electric}$$

$$\Delta kWh_{unit} = \left(kWh_{unit,b} - kWh_{unit,q}\right) \times \frac{N_{cycles}}{N_{cycles,ref}}$$

$$\Delta kWh_{total} = Cap \times N_{cycles} \times \left(\frac{1}{MEF_b} - \frac{1}{MEF_q}\right)$$

Annual Fuel Savings

$$\Delta Therms = \Delta Therms_{DHW} + \Delta Therms_{dryer}$$

Where,

$$\Delta Therms_{DHW} = \Delta kWh_{unit} \times \frac{F_{DHW}}{Eff_{DHW}} \times SF_{DHW,ff} \times 0.03412$$

$$\Delta Therms_{Dryer} = (\Delta kWh_{total} - \Delta kWh_{unit}) \times \frac{F_{loads}}{F_{dryer}} \times F_{dyer,mod} \times F_{dryer,corr} \times SF_{dryer,ff} \times 0.03412$$

$$\Delta kWh_{unit} = \left(kWh_{unit,b} - kWh_{unit,q}\right) \times \frac{N_{cycles}}{N_{cycles,ref}}$$

$$\Delta kWh_{total} = Cap \times N_{cycles} \times \left(\frac{1}{MEF_b} - \frac{1}{MEF_q}\right)$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-32 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{washer}	Annual electric energy savings attributed to clothes washer operation	Calculated	kWh/yr	
ΔkWh_{DHW}	Annual electric energy savings attributed to water heating	Calculated	kWh/yr	
ΔkWh_{dryer}	Annual electric energy savings attributed to dryer operation	Calculated	kWh/yr	
ΔkWh_{unit}	Annual electric energy savings of a unit exclusive of dryer operation	Calculated	kWh/yr	
ΔkWh_{total}	Annual electric energy savings of a unit inclusive of dryer operation	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{DHW}$	Annual fuel savings attributed to water heating	Calculated	Therms/yr	
$\Delta Therms_{dryer}$	Annual fuel savings attributed to dryer operation	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔH2O	Annual water savings	Calculated	Gal/yr	
Cap	Clothes washer capacity	Site-specific. If unknown, use 3.43	ft^3	[362]
N_{cycles}	Number of cycles per year	Site-specific. If unknown, look up in Table 3-35	cycles	[359]
$kWh_{unit,b}$	Baseline rated unit electricity consumption	Site-specific. If unknown, use 241	kWh/yr	[359]

Variable	Description	Value	Units	Ref
$kWh_{unit,q}$	Efficient rated unit electricity consumption	Site-specific. If unknown, use 97	kWh/yr	[359]
F_{washer}	Fraction of energy consumption attributed to clothes washer operation	Site-specific. If unknown, assume 0.20	N/A	[359]
F_{DHW}	Fraction of energy consumption attributed to water heating	Site-specific. If unknown, assume 0.80	N/A	[359]
F_{loads}	Fraction of washer loads dried in machine	Site-specific. If unknown, use 1.0	N/A	
Eff_{DHW}	Fuel water heater efficiency	Site-specific. If unknown, use 0.75	N/A	
WF_q	Water factor for efficient unit	Site-specific. If unknown, look up in Table 3-36	Gal/(cycle·ft³)	[362][363]
MEF_b	Modified Energy Factor of baseline unit	Look up in Table 3-33	N/A	[362][363]
MEF_q	Modified Energy Factor of efficient unit	Look up in Table 3-33	N/A	[362][363]
$SF_{DHW,electric}$	Electric DHW savings factor	Look up in Table 3-34	N/A	
$SF_{dryer,electric}$	Electric dryer savings factor	Look up in Table 3-34	N/A	
$SF_{DHW,ff}$	Fossil fuel DHW savings factor	Look up in Table 3-34	N/A	
$SF_{dryer,ff}$	Fossil fuel dryer savings factor	Look up in Table 3-34	N/A	
WF_b	Water factor for baseline unit	Look up in Table 3-36	Gal/(cycle·ft³)	[362][363]
CF	Electric coincidence factor	Look up in Table 3-37	N/A	[359]
PDF	Gas peak day factor	Look up in Table 3-37	N/A	
Hrs	Annual operating hours	265	Hrs/yr	[359]
$N_{cycles, ref}$	Reference number of cycles per year	392	cycles	[359]
F_{dryer}	Dryer usage factor	0.84	N/A	[359]
$F_{dryer,mod}$	Dryer usage factor in buildings with dryer and washer	0.95	N/A	[359]
$F_{dryer,corr}$	Fossil fuel dryer correction factor	1.12	N/A	[359]
0.03412	Unit conversion, therm/kWh	0.03412	Therm/kWh	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-33 Modified Energy Factor of Baseline and Efficienct Unit

Efficiency Level	Front Loading	Top Loading
Federal Standard	Before January 1, 2018	

Efficiency Level	Front Loading	Top Loading
	2.00	1.60
	On or After January 1, 2018	
	2.00	1.35
ENERGY STAR	2.20	

Table 3-34 DHW and Dryer Savings Factors

Fuel	$SF_{DHW,electric}$	$SF_{dryer,electric}$	$SF_{DHW,ff}$	$SF_{dryer,ff}$	Source
Electric	1.00	1.00	0	0	
Fossil Fuel	0	0	1.00	1.00	
Unknown	Look up in Appendix K: DHW and Space Heat Fuel Split	0.89	Look up in Appendix K: DHW and Space Heat Fuel Split	0.11	[364]

Table 3-35 Annual Cycles

Type	Number of Cycles
Multifamily Common Area	1,241
Laundromats	2,190

Table 3-36 Water Factor of Baseline and Efficient Unit

Efficiency Level	Front Loading	Top Loading
Federal Standard	Before January 1, 2018	
	5.5	8.5
	On or After January 1, 2018	
	4.1	8.8
ENERGY STAR	4.0	

Peak Factors

Table 3-37 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.029	[359]

Peak Factor	Value	Ref
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Non-Energy Impacts

$$\Delta H2O = Cap \times \left(WF_b - WF_q\right) \times N_{cycles}$$

Measure Life

The effective useful life (EUL) for a multifamily common area is 11.3 years. The EUL for laundromats is 7.1 years. [359]

References

[359] Regulations.gov, Energy Conservation Program: Energy Conservation Standards for Commercial Clothes Washers; Final Rule (2014). https://www.regulations.gov/document/EERE-2012-BT-STD-0020-0037

[360] Metered data from Navigant Consulting, *EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Appliance Rebate Program.* March 21, 2014, page 36. This data applies to residential applications. In the absence of metered data specific to multifamily common area and commercial laundromat applications, this coincidence value is used as a proxy given consistency with the PJM peak definition; however, this value is likely conservatively low for commercial applications and is a candidate for update should more applicable data become available .

[361] Clothes Washer Calculations for the ENERGY STAR Appliance Calculator. 2022. https://www.sfwmd.gov/sites/default/files/documents/calculator_energy_star_res_appliance_savings.xlsx.

[362] Based on the average commercial clothes washer volume of all units meeting ENERGY STAR V8.1 criteria listed in the ENERGY STAR database of certified products accessed on 03/07/2016. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%208.1%20Clothes%20Washer%20Final%20Specification%20-%20Partner%20Commitments%20and%20Eligibility%20Criteria.pdf

[363] Office of Energy Efficiency and Renewable Energy, Department of Energy, Energy Conservation Program: Energy Conservation Standards for Commercial Clothes Washers. https://www.federalregister.gov/documents/2021/12/20/2021-27461/energy-conservation-program-energy-conservation-standards-for-commercial-clothes-washers

[364] Space heat and DHW factors in Appendix from program data. Dryer fuel data from EIA Residential Energy Consumption Survey 2015, Table HC3.1, buildings with 5 or more units. https://www.eia.gov/consumption/residential/data/2015/#appliances

3.2.2 CLOTHES DRYERS

Market	Commercial/Multifamily
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Clothes Washer
Measure Last Reviewed	January 2023

Description

This measure covers residential grade clothes dryers meeting the criteria established under the ENERGY STAR® Program, Version 1.1, effective May 5, 2017, installed in small commercial settings. ENERGY STAR® clothes dryers have a higher combined energy factor (CEF), and save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through increased insulation, modifying operating conditions, improving air circulation, and improved efficiency of motors. Reduced dryer runtime is achieved through automatic termination of the dryer cycles based on temperature and moisture sensors. Clothes dryers originally qualified for the ENERGY STAR® label in May 2014. Clothes dryers that have earned this label are approximately 20% more efficient than non-qualified models.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline for energy savings calculations is a clothes dryer meeting the federal minimum combined energy factor for machines manufactured after January 2015. The minimum combined energy factor varies by clothes dryer type.

Efficient Case

A clothes dryer that is an ENERGY STAR® version 1.1 qualifying model.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = Cycles_{annual} \times Load \times \left(\frac{F_{elec,b}}{CEF_b} - \frac{F_{elec,q}}{CEF_q} \right)$$

Annual Fuel Savings

$$\Delta Therms = Cycles_{annual} \times Load \times \left(\frac{F_{fuel,b}}{CEF_b} - \frac{F_{fuel,q}}{CEF_q} \right) \times \frac{3{,}412}{100{,}000}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-38 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Cycles_{Annual}$	Number of dryer cycles per year	Site-specific. If unknown, look up in Table 3-40	Cycles	[365]
Load	Average total weight of clothes per drying cycle	Look up in Table 3-39	lbs	[365]
$F_{elec,b}$	Percentage of energy consumed that is derived from electricity for baseline dryer	Look up in Table 3-39	%	[371][372]
$F_{elec,q}$	Percentage of energy consumed that is derived from electricity for efficient dryer	Look up in Table 3-39	%	[371][372]
$F_{fuel,b}$	Percentage of energy consumed that is derived from fossil fuel for baseline dryer	Look up in Table 3-39	%	[371][372]
$F_{fuel,q}$	Percentage of energy consumed that is derived from fossil fuel for efficient dryer	Look up in Table 3-39	%	[371][372]
CEF_b	Combined energy factor for baseline dryer	Look up in Table 3-39	lb/kWh	[367]

Variable	Description	Value	Units	Ref
CEF_q	Combined energy factor for efficient dryer	Look up in Table 3-39	lb/kWh	[366]
Hrs	Annual run hours of clothes dryer	Site-specific. If unknown look up in Table 3-40	Hrs/yr	[365][370]
CF	Electric coincidence factor	Look up in Table 3-41	N/A	[368]
PDF	Gas peak day factor	Look up in Table 3-41	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-39 Clothes Dryer Values

Variable	Vented Gas Dryer	Ventless or Vented Electric, Standard ≥ 4.4 ft³	Ventless or Vented Electric, Compact (120V) < 4.4 ft³	Vented Electric, Compact (240V) < 4.4 ft³	Ventless Electric, Compact (240V) < 4.4 ft³
Load	8.45	8.45	3.00	3.00	3.00
$F_{elec,b}$[71]	0.16	1.00	1.00	1.00	1.00
$F_{elec,q}$	0.16	1.00	1.00	1.00	1.00
$F_{fuel,b}$[72]	0.84	0.00	0.00	0.00	0.00
$F_{fuel,q}$	0.84	0.00	0.00	0.00	0.00
CEF_b	3.30	3.73	3.61	3.27	2.55
CEF_q	3.48	3.93	3.80	3.45	2.68
Energy Star Most Efficient CEF_q		4.3	4.3	4.3	3.7

Table 3-40 Annual Dryer Cycles

Facility Type	Commercial – Multifamily	Laundromat
$Cycles_{Annual}$	1,241	2,190
Hrs[73]	1,158	2,044

[71] %Electric accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc). 16% was determined using a ratio of the electric to total savings from gas dryers given by ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.
[72] %Gas accounts for the fact that some of the savings on gas dryers comes from electricity (motors, controls, etc). 84% was determined using a ratio of the gas to total savings from gas dryers given by ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis.
[73] Assumes average of 56 minutes per cycle based on Ecova, 'Dryer Field Study', Northwest Energy Efficiency Alliance (NEEA) 2014.

Peak Factors

Table 3-41 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.029	[368]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 12 years [369].

References

[365] Savings Calculator for ENERGY STAR Qualified Appliances, ENERGY STAR, 2012. https://www.sfwmd.gov/sites/default/files/documents/calculator_energy_star_res_appliance_savings.xlsx

[366] *ENERGY STAR Program Requirements for Clothes Dryers -Partner Commitments Criteria ENERGY STAR ® Program Requirements Product Specification for Clothes Dryers Partner Commitments*. n.d. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%201.1%20Clothes%20Dryers%20Specification%20-%20Program%20Commitment%20Criteria%20and%20Eligibility%20Criteria_0.pdf

[367] PART 430 - ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS n.d. https://federalregister.gov. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#430.32

[368] *Mid-Atlantic Technical Reference Manual (TRM) V10.* (2020), https://neep.org/sites/default/files/media-files/trmv10.pdf

[369] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[370] Northwest Energy Efficiency Alliance (NEEA), 'Dryer Field Study', November 2014 https://ecotope-publications-database.ecotope.com/2014_005_1_DryerStudy.pdf

[371] *Mid-Atlantic Technical Reference Manual (TRM) V10* (2020). https://neep.org/sites/default/files/media-files/trmv10.pdf

[372] ENERGY STAR Draft 2 Version 1.0 Clothes Dryers Data and Analysis, August 2013. https://www.energystar.gov/sites/default/files/specs/ENERGY%20STAR%20Draft%202%20Version%201.0%20Clothes%20Dryers%20Data%20and%20Analysis.xlsx

3.2.3 CLOTHES DRYER MODULATING VALVE

Market	Commercial/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Clothes Washer
Measure Last Reviewed	January 2023

Description

This measure relates to the installation of a two-stage modulating gas valve retrofit kit on a standard commercial non-modulating gas dryer. Commercial gas clothes dryers found in coin-operated laundromats or on-premise laundromats (hospitals, hotels, health clubs, etc.) traditionally have a single firing rate which is sized properly for highest heat required in initial drying stages but is oversized for later drying stages requiring lesser heat. This causes the burner to cycle on/off frequently, resulting in less efficient drying and wasted gas. Replacing the single stage gas valve with a two-stage gas valve allows the firing rate to adjust to the changing heat demand, thereby reducing overall gas consumption.

Accurately estimating dryer energy consumption is complicated and challenging due to a variety of factors that influence cycle times and characteristics and ultimately drying energy requirements. Clothing loads can vary by weight, volume, fiber composition, physical structure, and initial water content, meaning that drying energy requirements can differ for any given cycle. Additionally, dryer settings selected by the user andinteractions with the site's HVAC systems are known to influence dryer performance. As better information becomes available, this characterization can be modified to allow for a more site-specific estimation of savings.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

A 30- to 250- pound capacity commercial gas dryer with no modulating capabilities.

Efficient Case

A 30- to 250-pound capacity commercial gas dryer retrofitted with a two-stage modulating gas valve kit.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = N_{Cycles} \times SF$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \mathrm{N/A}$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-42 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
N_{Cycles}	Number of dryer cycles per year	Site-specific. If unknown, look up in Table 3-43	Cycles/yr	[373]
SF	Savings factor	0.18	Therms/cycle	[374][373]
PDF	Gas peak day factor	Look up in Table 3-44	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-43 Estimated Dryer Cycles per Year

Application	Cycles per Year
Coin-Operated Laundromats	1,483
Multifamily Dryers	1,074
On-Premise Laundromats	3,607

Peak Factors

Table 3-44 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is equal to 10 years[373].

References

[373] *IL 2022 Illinois Statewide Technical Reference Manual for Energy Efficiency : Version 10* (2022), Pg 734. https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf

[374] IL TRM v10, pg 734. Based on Illinois weather data, and average dryer performance for laundromat (30 to 45lb) and hotel (75 to 170 lb) dryers.

3.2.4 REFRIGERATORS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/ISP/ Dual
End Use Subcategory	Kitchen
Measure Last Reviewed	January 2023

Description

This measure includes the installation of ENERGY STAR® compliant commercial refrigerators with an integral compressor and condenser. This measure is only applicable to horizontal or vertical self-contained refrigerators with solid or transparent doors.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Early Replacement: The baseline condition for the Early Replacement measure is the existing commercial refrigerator for the remaining useful life of the unit, and then for the remainder of the measure life the baseline becomes a new replacement unit meeting the minimum federal efficiency standard.

Time of Sale: The baseline condition is a standard-efficiency commercial refrigerator meeting, but not exceeding, federal energy efficiency standards.

Efficient Case

The efficient condition is a high-efficiency packaged commercial refrigerator meeting ENERGY STAR® Version 5.0 requirements.

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times (1 + HVAC_c) \times Days$$

Annual Fuel Savings

$$\Delta Therms = \left(kWh_b - kWh_q\right) \times HVAC_{ff} \times 10 \times Days$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{kWh_b - kWh_q}{Daily\ Hours}\right) \times (1 + HVAC_d) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\, using\ existing\ baseline) \times RUL + (\Delta kWh\, using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-45 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric savings	Calculated	kWh/yr	
$\Delta Therms$	Annual fue savings compared to existing unit	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings compared to existing unit	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
V	Refrigerator volume	Site-specific	ft^3	
Days	Number of days of operations in a year	Site-specific. If unknown, use 365 days	days	
Daily Hours	Hours of operation in a day	Site-specific. If unknown, use 24 hours	hours	
kWh_q	Annual energy consumption of qualifying efficient unit	Look up in Table 3-48	kWh	[376]

Variable	Description	Value	Units	Ref
kWh_b	Annual energy consumption of code-compliant baseline unit	Site-specific or look up in Table 3-47, Table 3-48	kWh	[375]
$HVAC_c$	HVAC interaction factor for annual electric energy consumption	0.080	N/A	
$HVAC_d$	HVAC interaction factor for peak demand at utility summer peak hour	0.175	N/A	
$HVAC_{ff}$	HVAC interaction factor for annual fossil fuel energy consumption	-0.002	MMBtu/kWh	
10	Unit conversion, Therm/MMBtu	10	Therm/MMBtu	
CF	Electric coincidence factor	Look up in Table 3-49	N/A	
PDF	Gas peak day factor	Look up in Table 3-49	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-46 Daily Energy Consumption of Code-Compliant Baseline Unit

Product Class	Daily Refrigerator Energy (kWh_b)
Vertical Closed	
Solid	*VCS.SC.M**
All volumes	*0.05 x V+1.36*
Transparent	*VCT.SC.M*
All volumes	*0.1 x V+0.86*
Horizontal Closed	
Solid	*HCS.SC.M*
All volumes	*0.05 x V+0.91*
Transparent	*HCT.SC.M*
All volumes	*0.06 x V+0.37*

Where V = unit volume in cubic feet
* DOE Equipment Class designations relevant to ENERGY STAR eligible product scope
(1) Equipment family code (HCS= horizontal closed solid, HCT=horizontal closed transparent, VCS= vertical closed solid, VCT=vertical closed transparent).
(2) Operating mode (SC=self-contained).
(3) Rating Temperature (M=medium temperature (38 °F), L=low temperature (0 °F)).

Table 3-47 Daily Energy Consumption of Existing Unit

Product Class	Daily Refrigerator Energy when existing unit was manufactured before 03/26/2017 (kWh_{ex})	Daily Refrigerator Energy when existing unit was manufactured after 03/27/2017 (kWh_{ex})
Vertical Closed		
Solid	*VCS.SC.M*	*VCS.SC.M*
All volumes	*0.10 x V+2.04*	*0.05 x V+1.36*
Transparent	*VCT.SC.M*	*VCT.SC.M*
All volumes	(0.12V + 3.34) x 365	(0.1 x V+0.86) x 365
Horizontal Closed		
Solid	*HCS.SC.M*	*HCS.SC.M*
All volumes	(0.10V+2.04) x 365	(0.05 x V+0.91) x 365
Transparent	*HCT.SC.M*	*HCT.SC.M*
All volumes	(0.12V + 3.34) x 365	(0.06 x V+0.37) x 365

Where V = unit volume in cubic feet

Table 3-48 Daily Energy Consumption of Qualifying Efficient Unit

Product Class	Daily Refrigerator Energy (kWh_q)
Vertical Closed	
Solid	*VCS.SC.M*
0 < V < 15	*0.0267 x V+0.8*
15 ≤ V < 30	*0.05 x V+0.45*
30 ≤ V < 50	*0.05 x V+0.45*
50 ≤ V	*0.025 x V+1.6991*
Transparent	*VCT.SC.M*
0 < V < 15	*0.095 x V+0.445*
15 ≤ V < 30	*0.05 x V+1.12*
30 ≤ V < 50	*0.076 x V+0.34*
50 ≤ V	*0.105 x V-1.111*
Horizontal Closed	
Solid or Transparent	*HCT.SC.M, HCS.SC.M*
All volumes	*0.05 x V+0.28*

Where V = unit volume in cubic feet

Peak Factors

Table 3-49 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	Appendix G: Natural Gas Peak Day Factors	

Measure Life

Table 3-50 Measure Life

Equipment	EUL	RUL	Ref
Commercial Reach-in Refrigerator	12	Site-specific. If unknown use 4 years	[378]

References

[375] Code of Federal Regulations, Energy Efficiency Program for Certain Commercial and Industrial Equipment, title 10, sec. 431.66 (2010).

[376] ENERGY STAR Program Requirements Product Specification for Commercial Refrigerators and Freezers Eligibility Criteria Version 5.0, ENERGY STAR ®, December 2022.

[377] Code of Federal Regulations, Energy Efficiency Program for Certain Commercial and Industrial Equipment, title 10, sec. 431.66 (2013).

[378] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020. http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.2.5 FREEZERS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/ISP/Dual
End Use Subcategory	Kitchen
Measure Last Reviewed	January 2023

Description

This measure covers the installation of ENERGY STAR® compliant commercial freezers operating with an integral compressor and condenser. Eligible equipment includes commercial freezers and refrigerator-freezers. This measure is only applicable to horizontal or vertical self-contained equipment with solid or transparent doors.

In the case of early replacement of a working unit where the unit would have otherwise been installed until failure, remaining useful life (RUL) savings are claimed additional to the estimated useful life (EUL) savings of the new unit. Early replacement savings are calculated between existing unit and efficient unit consumption during the assumed remaining life of the existing unit, and between new baseline unit and efficient unit consumption for the remainder of the measure life. Assume that the remaining useful life of the existing unit equals 1/3 of the measure's effective useful life.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Early Replacement (EREP) and Direct Install (DI): Early replacement and DI uses a dual baseline. The baseline is the existing unit for the remaining life of the existing unit and the baseline is a code-compliant/standard efficiency unit for the full measure life of the installed equipment.

Time of Sale (TOS) and New Construction (NC): The baseline condition is a minimally code compliant commercial freezer.

Baseline annual electric consumption shall align with federally mandated maximum energy use associated with the Product Class and the chilled or frozen compartment volume (V) of the qualifying equipment [379]. Volume specification shall be taken from ENERGY STAR® qualified products listing or specification sheet of the proposed equipment.

Efficient Case

The compliance condition is an ENERGY STAR® version 5.0 qualified commercial refrigerator-freezer or freezer. Annual electric energy consumption of the qualifying equipment shall come from application. Volume specification shall be taken from ENERGY STAR® qualified products listing or specification sheet of the proposed equipment.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times (1 + HVAC_c) \times Days$$

Annual Fuel Savings

$$\Delta Therms = \left(kWh_b - kWh_q\right) \times HVAC_{ff} \times 10 \; \times Days$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{kWh_b - kWh_q}{Daily\ Hours}\right) \times (1 + HVAC_d) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Time of Sale (compared to code baseline):

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-51 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings for Time of Sale	Calculated	Therms/yr	

Variable	Description	Value	Units	Ref
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
V	Freezer unit volume	Site-specific	ft^3	
Days	Number of days of operations in a year	Site-specific. If unknown, use 365 days	days	
Daily Hours	Hours of operation in a day	Site-specific. If unknown, use 24 hours	hours	
kWh_q	Annual energy consumption of qualifying efficiency unit	Site-specific. If unknown, look up in Table 3-53	kWh/yr	[381]
kWh_b	Annual energy consumption of code-compliant baseline unit	Site-specific or look up in Table 3-52, Table 3-53	kWh/yr	[379]
CF	Electric coincidence factor	Look up in Table 3-55	N/A	
PDF	Gas peak day factor	Look up in Table 3-55	N/A	
$HVAC_c$	HVAC interaction factor for annual electric energy consumption	0.080	N/A	
$HVAC_d$	HVAC interaction factor for peak demand at utility summer peak hour	0.175	N/A	
$HVAC_{ff}$	HVAC interaction factor for annual fossil fuel energy consumption	-0.002	MMBtu/kWh	
8,760	Hours per year	8,760	Hrs/yr	
10	Unit conversion, Therm/MMBtu	10	Therm/MMBtu	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-52 Current Federal Standard Baseline Equipment Daily Energy Consumption

Type	Freezer	
	Solid Door	Transparent Door
Vertical	$0.22 \times V + 1.38$	$0.29 \times V + 2.95$
Horizontal	$0.06 \times V + 1.12$	$0.08 \times V + 1.23$

Table 3-53 Energy Star Equipment Daily Energy Consumption

Volume (ft^3)	Vertical Closed Freezer		Horizontal Closed Freezer
	Solid Door	Transparent Door	Solid or Transparent Door
$0 < V < 15$	$0.21 \times V + 0.9$	$0.232 \times V + 2.36$	$0.057 \times V + 0.55$
$15 \leq V < 30$	$0.12 \times V + 2.248$	$0.232 \times V + 2.36$	$0.057 \times V + 0.55$
$30 \leq V < 50$	$0.258 \times V - 2.703$	$0.232 \times V + 2.36$	$0.057 \times V + 0.55$
$50 \leq V$	$0.142 \times V + 4.445$	$0.232 \times V + 2.36$	$0.057 \times V + 0.55$

Table 3-54 Existing Equipment Daily Energy Consumption

Type	Freezer	
	Solid Door	Transparent Door
Manufactured after 03/27/2017		
Vertical	$0.22 \times V + 1.38$	$0.29 \times V + 2.95$
Horizontal	$0.06 \times V + 1.12$	$0.08 \times V + 1.23$
Manufactured before 03/27/2017		
Vertical	$0.40 \times V + 1.38$	$0.75 \times V + 4.10$
Horizontal	$0.40 \times V + 1.38$	$0.75 \times V + 4.10$

Peak Factors

Table 3-55 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	[379]
Natural gas peak day factor (PDF)	N/A	

Measure Life

Table 3-56 Measure Life

Equipment	EUL	RUL	Ref
Freezer	12	Site-specific. If unknown, use 4 years	[380]

References

[379] 10 CFR Appendix A to Subpart C of Part 431 – Uniform Test Method for the Measurement of Energy Consumption of Commercial Refrigerators, Freezers, and Refrigerator-Freezers. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-C/subject-group-ECFR8115bf7451f830f/section-431.66

[380] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, *Effective/Remaining Useful Life Values*, California Public Utilities Commission (December 16, 2008).

[381] ENERGY STAR® Program Requirements Product Specification for Commercial Refrigerators and Freezers, Eligibility Criteria Version 5.0. (2022).

3.2.6 DEHUMIDIFIER

Market	Commercial/Multifamily
Baseline Condition	TOS/NC
Baseline	Code/ISP
End Use Subcategory	Indoor Environment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of commercial stand-alone or ducted dehumidifiers meeting the minimum qualifying efficiency standards established under the ENERGY STAR® Program, Version 5.0, effective October 31, 2019. With a higher Energy Factor than comparable non-qualified models, ENERGY STAR® dehumidifiers have more efficient refrigeration coils, compressors, and fans that use less energy to remove moisture in Commercial buildings. Dehumidifiers originally qualified for the ENERGY STAR® label in January 2001. Dehumidifiers that have earned this label are approximately 15% more efficient than non-qualified models. This measure is restricted to dehumidifiers with a product moisture removal capacity of less than or equal to 185 pints/day.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline condition is a stand-alone or ducted dehumidifier meeting the minimum effective federal standard for performance.

Dehumidifiers manufactured and distributed in commerce on or after June 13, 2019 must meet the energy conservation standards, rated in Integrated Energy Factor as specified in the Code of Federal Regulations.

Efficient Case

The compliance condition is an ENERGY STAR® v. 5 qualified stand-alone or whole-house dehumidifier.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{pints/day \times 0.473 \times hrs}{24} \times \left(\frac{1}{IEF_b} - \frac{1}{IEF_q}\right)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-57 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Pints/day	Product capacity to remove moisture	Site-specific	pints/day	
hrs	Annual run hours of dehumidifier	1,632	N/A	[382]
IEF_b	Basline Integrated Energy Factor	Look up in Table 3-58 & Table 3-59	liters/kWh	[383]
IEF_q	Energy Efficient Integrated Energy Factor	Site-specific. If unknown, look up in Table 3-60 & Table 3-61	liters/kWh	[384]
0.473	Conversion factor from liters to pint	0.473	liters/pint	
24	Hours in one day	24	N/A	
CF	Electric coincidence factor	0.405	N/A	[385]
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-58 Stand-Alone Dehumidfiers Baseline Integrated Energy Factor

Product Capacity (pints/day)	Integrated Energy Factor (liters/kWh)
≤ 25.00	1.30
25.01 to 50.00	1.60

Product Capacity (pints/day)	Integrated Energy Factor (liters/kWh)
≥50.01	2.80

Table 3-59 Whole-Home (Ducted) Dehumidifiers Baseline Integrated Energy Factor

Product Case Volume (ft^3)	Integrated Energy Factor (liters/kWh)
≤ 8.0	≥1.77
> 8.0	≥2.41

Table 3-60 Stand-Alone Dehumidfiers Energy Efficient Integrated Energy Factor

Product Capacity (pints/day)	Integrated Energy Factor (liters/kWh)
≤ 25.00	≥1.57
25.01 to 50.00	≥1.80
≥50.01	≥3.30

Table 3-61 Whole-Home (Ducted) Dehumidifiers Energy Efficient Integrated Energy Factor

Product Case Volume (ft^3)	Integrated Energy Factor (liters/kWh)
≤ 8.0	≥2.09
> 8.0	≥3.30

Peak Factors

Table 3-62 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 12 years [386].

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-63 Measure Life

Equipment	EUL	RUL	Ref
Dehumidifier	12	4	[386]

References

[382] "ENERGY STAR Appliance Calculator". https://www.energy.gov/energysaver/maps/appliance-energy-calculator. n.d. Accessed December 21, 2022.

[383] 10 CFR 430.32(v)(2), January 2023 https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32#p-430.32(v)(2)

[384] ENERGY STAR® Program Requirements Product Specification for Dehumidifiers, Eligibility Criteria Version 5.0, October 2019.

[385] Dehumidifier Metering in PA and Ohio by ADM from 7/17/2013 to 9/22/2013. 31 Units metered. Assumes all non-coincident peaks occur within window and that the average load during this window is representative of the June PJM days as well.

[386] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 9, January 2022. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf

3.2.7 ROOM AIR CONDITIONER

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/DI
Baseline	Code/Dual
End Use Subcategory	Indoor Environment
Measure Last Reviewed	January 2023

Description

This measure relates to the purchase and installation of a room air conditioning unit that meets the ENERGY STAR minimum qualifying efficiency specifications as presented in this section. This measure is for ENERGY STAR room air conditioner units installed in small commercial spaces. All HVAC applications other than comfort cooling and heating, such as process cooling, are defined as non-standard applications and are ineligible for this measure.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Room air conditioner having energy efficiency ratio (EER) as per Code of Federal Regulation's combined energy efficiency ratio (CEER).

Efficient Case

Room air conditioner meeting the requirements of Energy Star 4.2 room air conditioner specification.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = EFLH_c \times Cap \times \left(\frac{1}{CEER_b} - \frac{1}{CEER_q}\right)/1{,}000$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{EFLH_c} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-64 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Cap	Cooling capacity of efficient equipment	Site-specific	Btu/hr	
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	Lookup in Appendix C: Heating and Cooling EFLH, limit to small commercial buildings	Hours	[387]
$CEER_b$	Efficiency of baseline unit	Look up in Table 3-65	Btu/hr/watt	[388]
$CEER_q$	Efficiency of efficient unit	Site specific or defaults in lookup in Table 3-65	Btu/hr/watt	[389]
CF	Electric coincidence factor	Look up in Table 3-66	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	
1,000	Conversion from watts to kW	1,000	Watts/kW	

Table 3-65 Standard and ENERGY STAR CEER values for room air conditioner

Product Type and Class (Btu/hour)		Federal standard with louvered sides (CEER)	Federal standard without louvered sides (CEER)	ENERGY STAR with louvered sides (CEER)	ENERGY STAR without louvered sides (CEER)
Without reverse cycle	<6,000	11.0	10.0	12.1	11.0
	6,000 to 7,999	11.0	10.0	12.1	11.0
	8,000 to 10,999	10.9	9.6	12.0	10.6
	11,000 to 13,999	10.9	9.5	12.0	10.5
	14,000 to 19,999	10.7	9.3	11.8	10.2
	20,000 to 27,999	9.4	9.4	10.3	10.3
	≥28,000	9.0	9.4	9.9	10.3
With reverse cycle	<14,000	N/A	9.3	N/A	10.2
	≥14,000	N/A	8.7	N/A	9.6
	<20,000	9.8	N/A	10.8	N/A
	≥20,000	9.3	N/A	10.2	N/A
Casement-only[74]		9.5		10.5	
Casement slider[75]		10.4		11.4	

Peak Factors

Table 3-66 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.31	[390]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

74 Casement-only refers to a RAC designed for mounting in a casement window with an encased assembly with a width of ≤ 14.8 inches and a height of ≤ 11.2 inches.

75 Casement-slider refers to a RAC with an encased assembly designed for mounting in a sliding or casement window with a width of ≤ 15.5 inches.

Table 3-67 Measure Life

Equipment	EUL	RUL	Ref
Room Air Conditioner	9	3	[391]

References

[387] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.

[388] Code of Federal Regulations – Title 10, Chapter II, Subchapter D, Part 430, Subpart C, §430.32., January 2023 https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[389] ENERGY STAR Program Requirements for Room Air Conditioners, Eligibility Criteria, Version 4.0, January 2023 https://www.energystar.gov/products/heating_cooling/air_conditioning_room/key_product_criteria

[390] NEEP, Mid-Atlantic Technical Reference Manual, V8. pp 77-80., May 2018 https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V8_0.pdf

[391] PA TRM Energy Efficiency and Conservation Programs (TRM), Version 9, January 2023.

3.2.8 WATER COOLER

Market	Commercial/Multifamily
Baseline Condition	NC/TOS
Baseline	Code
End Use Subcategory	Kitchen
Measure Last Reviewed	January 2023

Description

This measure estimates savings for installing ENERGY STAR Water Coolers compared to standard efficiency equipment in commercial applications. The measurement of energy and demand savings is based on a deemed savings value multiplied by the quantity of the measure.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Water cooler meeting Energy Star v. 2.0 Water Cooler requirements as directed by N.J. PL 2021, c. 464.

Efficient Case

ENERGY STAR v. 3.0 compliant water cooler.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times 365$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hr} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-68 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Hr	Annual hours of operation	Site-specific, if unknown assume 8,760	Hrs	
kWh_b	Energy use of baseline water cooler	Look up in Table 3-69	kWh/day	[392]
kWh_q	Energy use of energy efficient water cooler	Site-specific, if unknown look up in Table 3-69	kWh/day	[393]
CF	Electric coincidence factor	Look up in Table 3-70	N/A	
PDF	Gas peak day factor	Look up in Table 3-70	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-69 Water Cooler Energy Use

Energy Star Water Cooler Type Product Capacity Class, and Conditioning Method	Baseline kWh_b (kWh/day)	Default Efficient kWh_q (kWh/day)
Cold Only	0.16	0.16
Hot & Cold – Low Capacity[76]	0.87	0.68
Hot & Cold – High Capacity[77]	0.87	0.80
Hot & Cold On-Demand	0.18	0.18

[76] A water cooler with a cold-water dispenser capacity of 0.50 gallons per hour or less, as measured per ANSI/ASHRAE Standard 18. For units that also provide hot water, the unit must have a hot-water dispenser capacity that is equal to or less than 41 exact 6 oz. cups per hour, as rated per ANSI/ASHRAE Standard 18.

[77] A water cooler with a cold-water dispenser capacity that is greater than 0.50 gallons per hour, as measured per ANSI/ASHRAE Standard 18. For units that also provide hot water, the unit must have a hot-water dispenser capacity greater than 41 exact 6 oz. cups per hour, as rated per ANSI/ASHRAE Standard 18.

Peak Factors

Table 3-70 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	[394]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years. [392]

References

[392] ENERGY STAR Product Specifications for Water Coolers Version 2.0. https://www.energystar.gov/sites/default/files/specs//ES%20WC%20V2%200%20Spec.pdf

[393] ENERGY STAR Product Specifications for Water Coolers Version 3.0. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Verison%203.0%20Water%20Coolers%20Final%20Specification_0.pdf

[394] Assumes 24/7 operation. Site-specific load shape information should be used if known.

3.3 APPLIANCE RECYCLING

3.3.1 REFRIGERATOR & FREEZER RECYCLING

Market	Commercial
Baseline Condition	ERET
Baseline	Existing
End Use Subcategory	Recycling
Measure Last Reviewed	January 2023

Description

In many cases, when a refrigerator or freezer is replaced by a building owner, the existing unit is retained, sold, or donated for use elsewhere, representing additional load on the grid. This measure covers recycling of the existing, functional equipment, thereby eliminating the consumption associated with that equipment. Refrigerator and freezer recycling programs (also called "bounty" programs) receive energy savings credit for permanently removing inefficient, functional refrigerators and freezers from the electric grid.

This measure covers the recycling of primary (i.e., installed in a kitchen) and secondary (i.e., installed elsewhere) refrigerators, refrigerator-freezers and freezers. To account for the fact that secondary equipment is occasionally installed and operating for only part of the year, a part-time use adjustment factor has been developed and embedded within the gross savings estimate for secondary units to establish average annual per unit deemed electric savings.

This measure does not cover the recycling of equipment classified by the Code of Federal Regulations as "Compact refrigerator/refrigerator-freezer/freezer". This refers to any refrigerator, refrigerator-freezer or freezer with a total refrigerated volume of less than 7.75 ft3 (220 liters), where the total refrigerated volume has been determined in accordance with the procedure prescribed in Appendix A (refrigerators and refrigerator-freezers) or B (freezers) of 10 CFR 430 Subpart B.112.

Note: The following values are developed for residential equipment installed in commercial buildings. There currently is no methodology for recycling of commercial scale refrigerators and freezers.

Baseline Case

The savings calculations below apply to recycling of a functioning primary or secondary refrigerator, refrigerator-freezer, or freezer with total refrigerated volume of 7.75 ft3 (220 liters) or more.

Efficient Case

The compliance condition is the recycling of an existing refrigerator or freezer as defined in the Measure Description section above.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{\Delta kWh}{unit}\right)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{\Delta kW}{unit}\right)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-71 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔkWh/unit	Energy Savings	Lookup in Table 3-72	kWh	[396]
ΔkW/unit	Demand Savings per unit	Lookup in Table 3-72	kWh	[396]
CF	Electric coincidence factor	Look up in Table 3-73	N/A	
PDF	Gas peak demand factor	Look up in Table 3-73	N/A	
EUL	Effective useful life	See	Years	[395]

Table 3-72 Default Values for Annual Energy and Peak Demand Savings

	Primary Refrigerator	Secondary Refrigerator	Freezer
ΔkWh/unit	958	581	593
ΔkW/unit	0.15	0.10	0.10

Peak Factors

Table 3-73 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 5 years for a refrigerator and 4 years for a freezer [395].

References

[395] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[396] DNV, Appliance Recycling Program Impact Evaluation Study, June 2021 https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BE846898E-5EAE-4F42-9F97-385982740AC6%7D

3.3.2 ROOM AC UNIT RECYCLING

Market	Commercial
Baseline Condition	ERET
Baseline	Existing
End Use Subcategory	Recycling
Measure Last Reviewed	January 2023

Description

In many cases where a business removes an appliance, the existing unit is retained, sold, or donated for use elsewhere and represents additional load on the grid. This measure covers removing the existing functional equipment before its natural end of life, thereby eliminating the consumption associated with that equipment. This measure is applicable to commercial and multifamily high-rise buildings.

A room air conditioner is an appliance, other than a "packaged terminal air conditioner," which is powered by a single-phase electric current and that is an encased assembly designed as a unit for mounting in a window or through the wall for the purpose of delivering conditioned air to an enclosed space.

Baseline Case

The baseline condition is the existing room air conditioning unit.

Efficient Case

The existing room air conditioning unit is removed from service.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{Hrs \times Btu/h}{EER \times 1{,}000} \times PartUse$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{Btu/h}{EER \times 1{,}000} \times PartUse \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-74 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Btu/h	Capacity of replaced unit	Site-specific, if unknown assume 8,500	Btu/hr	[399]
EER	Efficiency of existing unit	Site-specific, if unknown assume 9.8	Btu/W/hr	[400]
Hrs	Run hours of A/C unit	Site-specific, if unknown assume 325	Hours	[398]
PartUse	Factor to account for units that are not in daily use throughout entire cooling season, as reported by applicant	Site-specific, if unknown assume 0.34	N/A	[403]
CF	Electric coincidence factor	Look up in Table 3-75	N/A	
PDF	Gas peak day factor	Look up in Table 3-75	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 3-75 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.3	[399]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 3 years. [397]

References

[397] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx .

[398] From MidAtlantic TRM v10: "VEIC calculated the average ratio of FLH for Room AC (provided in RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008) to FLH for Central Cooling at 31%. Applying this to the FLH for Central Cooling provided for Baltimore (1050) we get 325 FLH for Room AC."

[399] RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners (June 23, 2008 p. 22). Btu/h in this measure based on maximum capacity average in report, CF in this measure consistent with factors presented in report. https://www.puc.nh.gov/electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/124_SPWG%20Room%20%20AC%20Evaluation%20FINALReport%20June%2023%20ver7.pdf

[400] Minimum Federal Standard for most common room AC type (8000-14,999 capacity range with louvered sides) per federal standards from 10/1/2000 to 5/31/2014.

[401] Minimum Federal Standard for most common Room AC type (8000-14,999 capacity range with louvered sides). Current federal standards use CEER while previous federal standards used EER for efficiency levels.

[402] *Mid-Atlantic TRM Manual: Version 10* (NEEP, 2020), Pg 110 https://neep.org/mid-atlantic-technical-reference-manual-trm-v10.

[403] Cadmus analysis, EmPOWER 2018 P1 & P2 ARP participant survey

3.3.3 DEHUMIDIFIER RECYCLING

Market	Commercial
Baseline Condition	ERET
Baseline	Existing
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

In many cases, when a dehumidifier is replaced by a building owner, the existing unit is retained, sold or donated for use elsewhere, representing additional load on the grid. This measure covers recycling of existing, functional, portable dehumidifiers, thereby eliminating the consumption associated with that equipment. This measure should target, but not be limited to dehumidifiers put into service prior to June 2019. If provided data indicates the unit is replaced rather than retired, savings shall be based on the Commercial Dehumidifier measure in this TRM.

Baseline Case

The baseline condition is the existing inefficient dehumidifier.

Efficient Case

The existing inefficient dehumidifier is removed from service and not replaced.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = capacity \times \frac{0.473}{24} \times hrs \times \frac{1}{L/kWh}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times RUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-76 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Capacity	Capacity of the unit	Site-specific. If unknown, use 56	pints/day	[410]
L/kWh	Dehumidifier Efficiency	Look up in Table 3-77	L/kWh	[405][407][408]
0.473	Conversion factor	0.473	L/pint	
24	Conversion factor	24	Hr/day	
Hrs	Hours of use	1632	Hours	[405]
CF	Electric coincidence factor	Look up in Table 3-78	N/A	
PDF	Gas peak day factor	Look up inTable 3-78	N/A	
RUL	Remaining useful life	See Measure Life Section	Years	

Table 3-77 Dehumidifier Capacity and Efficiency

Capacity Range (pints/day)	ENERGY STAR Labeled (L/kWh)	Non-ENERGY STAR Labeled	
		Manufacture date before Oct. 2012 (≥L/kWh)	Manufacture date of Oct. 2012 or later (≥L/kWh)
≤ 25	1.57	1.00	1.35
>25 to ≤ 35	1.80	1.20	1.35
>35 to ≤ 45	1.80	1.30	1.50
>45 to ≤ 50	1.80	1.30	1.60
>50 to ≤ 55	3.30	1.30	1.60
>54 to ≤ 75	3.30	1.50	1.70

Capacity Range (pints/day)	ENERGY STAR Labeled (L/kWh)	Non-ENERGY STAR Labeled	
		Manufacture date before Oct. 2012 (≥L/kWh)	Manufacture date of Oct. 2012 or later (≥L/kWh)
>75 to ≤ 185	3.30	2.25	2.50

Peak Factors

Table 3-78 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.405	[409]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) is 4 years [404].

References

[404] CA DEER gives the following rule-of-thumb for remaining useful life: RUL = (1/3) X EUL. As the Energy Star Dehumidifier [replacement] uses an EUL of 12 years, we have a suggested RUL of (1/3) X 12 years = 4 years.

[405] Savings Calculator for ENERGY STAR® Qualified Appliances Version 3.0 Last Updated October 1, 2012.

[406] ENERGY STAR® Program Requirements for Dehumidifiers, Version 5.0, February 2019.

[407] 42 U.S.C, Title 42 Chapter 77, Subchapter III, Part A, (cc)(1) and (cc)(2). https://uscode.house.gov/view.xhtml?path=/prelim@title42/chapter77/subchapter3&edition=prelim

[408] Code of Federal Regulations Title 10, Chapter 2, Subchapter D, Part 430, Subpart C (v)(1). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C

[409] Dehumidifier Metering in PA and Ohio by ADM from 7/17/2013 to 9/22/2013. 31 Units metered. Assumes all non-coincident peaks occur within window and that the average load during this window is representative of the June PJM days as well.

[410] *Mid-Atlantic Technical Reference Manual (TRM) V10.* (2020), https://neep.org/sites/default/files/media-files/trmv10.pdf

3.4 FOODSERVICE

3.4.1 OVENS, FRYER, STEAMER & GRIDDLE

Market	Commercial
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Cooking equipment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of qualified commercial kitchen equipment that exceeds the efficiency standards specified in the New Jersey P.L. 2021, c. 464 meets the descriptions below.

- Convection Ovens [412] – This measure includes gas and electric commercial convection ovens. A convection oven forces hot dry air over the surface of a food product. A full-size convection oven can accommodate standard full-size sheet pans measuring 18 x 26 x 1 inch. A half-size convection oven can accommodate half-size sheet pans measuring 18 x 13 x 1 inch. Though not subject to minimum standards specified in the New Jersey P.L. 2021, c. 464, the baseline for half-size gas convection ovens were taken from a Pacific Gas & Electric workpaper [416].
- Rack Ovens [412] – This measure includes gas commercial rack ovens. A rack oven is a high-capacity oven in which a rack is wheeled into the oven and can be rotated during the baking process. Single and double rack ovens are included in this measure.
- Steamers [413] – This measure includes gas and electric commercial steamers, also known as compartment steamers. A steamer is a device that contains one or more food steaming compartments in which the energy in the steam is transferred to the food by direct contact. To calculate the savings for this measure, the number of pans must be known. Countertop, wall-mounted, and floor models mounted on a stand, pedestal, or cabinet-style base are included. Commercial steamer microwave ovens are not included in this measure.
- Fryers [414]– This measure includes gas and electric commercial deep-fat fryers. A deep-fat fryer is an appliance in which oils are placed to such a depth that the cooking food is essentially supported by displacement of the cooking fluid rather than by the bottom of the vessel. Depending on the fryer type, heat is delivered to the cooking fluid by means of an immersed electric element or band-wrapped vessel (electric fryers), or by heat transfer from gas burners through either the walls of the fryer or through tubes passing through the cooking fluid (gas fryers). Standard fryers and large vat fryers are included in this measure.
- Griddles [415] – This measure includes single-sided gas and electric commercial griddles. A single-sided commercial griddle is a commercial appliance designed for cooking food in oil or its own juices by direct contact with either a flat, smooth, hot surface or a hot channeled cooking surface where plate temperature is thermostatically controlled. To calculate the energy savings in this measure, the griddle dimensions must be known. This measure does not include double-sided gas or electric commercial griddles.

- Gas Conveyor Ovens – Though not eligible for ENERGY STAR® qualification, this measure additionally covers the installation of energy efficient gas conveyor ovens. Conveyor ovens cook food by carrying it on a moving belt through a heated chamber. Qualifying conveyor ovens have baking efficiencies greater than or equal to 42% and idle energy rates less than or equal to 57,000 Btu/h, per assumed efficiency of qualified equipment by Pacific Gas and Electric workpaper, where 1 pizza equals 0.76 lbs [417].

Baseline Case

The baseline idle energy and cooking efficiency is compliant with the New Jersey P.L. 2021, c. 464 minimum standards, which establishes Energy Star Program Requirements for Commercial Oven Version 2.2 as the baseline for electric and gas convection ovens and gas rack ovens, Energy Star Program Requirements for Commercial Fryers Version 2.0 as the baseline for electric and gas fryers and Energy Star Program Requirements for Commercial Steam Cookers, Version 1.2 as the baseline for electric and gas steamers.[78] Preheat energy and all values for half size gas convection ovens, conveyor ovens and griddles are reported from referenced FSTC sources.

Table 3-79 Equipment Baselines Case Default Characteristics

Equipment	$Btu_{preheat,baseline}$ (Btu)	$Btu/h_{idle,baseline}$ (Btu/h)	$(lbs/hr)_{baseline}$	$Eff_{baseline}$	Ref
Convection Oven, Electric, Full Size	5,118	5,459	70	0.71	[416][412]
Convection Oven, Electric, Half Size	3,412	3,412	45	0.71	[416][412]
Convection Oven, Gas, Full Size	19,000	12,000	70	0.46	[416][412]
Convection Oven, Gas, Half Size	13,000	12,000	45	0.30	[416]
Conveyor Oven, Gas	21,270	55,000	114	0.30	[426]
Rack Oven, Gas, Double Rack	100,000	30,000	250	0.52	[418][412]
Rack Oven, Gas, Single Rack	50,000	25,000	130	0.48	[422][412]
Steamer, Electric	5,118	3-pan: 1,365 4-pan: 1,808 5-pan: 2,286 6-pan and larger: 2,730	11.7 x No. of pans	0.50	[413][419]
Steamer, Gas	20,000	3-pan: 6,250 4-pan: 8,350 5-pan: 10,400	23.3 x No. of pans	0.38	[413][419]

[78] https://legiscan.com/NJ/bill/A5160/2020.

Equipment	$Btu_{preheat,baseline}$ (Btu)	$Btu/h_{idle,baseline}$ (Btu/h)	$(lbs/hr)_{baseline}$	$Eff_{baseline}$	Ref
		6-pan and larger: 12,500			
Fryer, Electric	8,189	3,412	65	0.80	[420][427]
Fryer, Gas	18,500	9,000	60	0.50	[420][427]
Griddle, Electric	4,436 x Griddle Width (ft)	2,730 x Griddle Width (ft)	11.7 x Griddle Width (ft)	0.60	[421]
Griddle, Gas	7,000 x Griddle Width (ft)	7,000 x Griddle Width (ft)	8.4 x Griddle Width (ft)	0.30	[421]

Efficient Case

The compliance condition is food service equipment that exceeds the minimum efficiency specified in New Jersey P.L. 2021, c. 464 or, in the case of conveyor ovens, half-size gas convection ovens and griddles, equipment aligning with FSTC assumptions for energy efficient products meeting the minimum performance specifications listed in the table below. Operating characteristics shall be taken from application. When unavailable, default characteristics shall be taken from Table 3-80.

Table 3-80 Equipment Efficient Case Default Characteristics

Equipment	$Btu_{preheat,ee}$ (Btu)	$Btu/h_{idle,ee}$ (Btu/h)	$(lbs/hr)_{ee}$	Eff_{ee}	Ref
Convection Oven, Electric, Full Size	3,412	4,606	82	0.76	[416][428]
Convection Oven, Electric, Half Size	3,071	2,593	53	0.76	[416][428]
Convection Oven, Gas, Full Size	11,000	9,349	82	0.51	[416][428]
Convection Oven, Gas, Half Size	7,500	4,293	53	0.53	[416][428]
Conveyor Oven, Gas	15,000	40,000	158	0.46	[417][426]
Rack Oven, Gas, Double Rack	85,000	24,600	280	0.56	[418][429]
Rack Oven, Gas, Single Rack	44,000	19,733	140	0.51	[422][429]
Steamer, Electric	5,118	990	14.7 x No. of pans	0.70	[419][430]
Steamer, Gas	9,000	1,221	20.8 x No. of pans	0.47	[419][430]
Fryer, Electric, Standard	6,483	2,327	71	0.86	[420][431]

Equipment	$Btu_{preheat,ee}$ (Btu)	$Btu/h_{idle,ee}$ (Btu/h)	$(lbs/hr)_{ee}$	Eff_{ee}	Ref
Fryer, Gas, Standard	16,000	7,571	67	0.52	[420][431]
Griddle, Electric	2,389 x Griddle Width (ft)	1,000 x Griddle Area (ft^2)	16.3 x Griddle Width (ft)	0.75	[421]
Griddle, Gas	5,000 x Griddle Width (ft)	2,068 x Griddle Area (ft^2)	16.4 x Griddle Width (ft)	0.46	[421]

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = days \times \frac{(\Delta Btu_{preheat} + \Delta Btu_{idle} + \Delta Btu_{cooking})}{3412}$$

Annual Fuel Savings

$$\Delta Therms = days \times \frac{(\Delta Btu_{preheat} + \Delta Btu_{idle} + \Delta Btu_{cooking})}{100{,}000}$$

Where:

$$\Delta Btu_{preheat} = N_{preheat} \times (Btu_{preheat,baseline} - Btu_{preheat,ee})$$

$$\Delta BTU_{idle} = Btu/h_{idle,baseline} \times [hrs - N_{preheat} \times hrs_{preheat} - \frac{lbs}{(lbs/hr)_{baseline}}] - Btu/h_{idle,ee} \times [hrs - N_{preheat} \times hrs_{preheat} - \frac{lbs}{(lbs/hr)_{ee}}]$$

$$\Delta Btu_{cooking} = lbs \times Q_{food} \times (\frac{1}{Eff_{baseline}} - \frac{1}{Eff_{ee}})$$

NOTE: $\Delta Btu_{preheat}$, ΔBtu_{idle} and $\Delta Btu_{cooking}$ terms can be calculated per the equations above using either actual qualifying equipment specs or default values as defined in the Common Variables, Baseline Efficiencies, Compliance Efficiency, and Operating Hours sections below, or looked up from Table 3-83.

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{(days \times hrs)} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-81 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta Btu_{preheat}$	Daily preheat energy savings	Calculate based on calculations above or look up in Table 3-83	Btu	
ΔBtu_{idle}	Daily idle energy savings	Calculate based on calculations above or look up in Table 3-83	Btu	
$\Delta Btu_{cooking}$	Daily cooking energy savings	Calculate based on calculations above or look up in Table 3-83	Btu	
days	Operating days per year	Site-specific, if unknown look up based on facility type in Table 3-82	Btu	
hrs	Daily operating hours	Site-specific, if unknown look up based on facility type in Table 3-82	hours	
$Btu_{preheat,baseline}$	Basline Equipment preheat energy	Look up based on qualifying equipment type in Table 3-79	Btu	
$Btu_{preheat,ee}$	Energy Efficient Equipment preheat energy	Site-specific, if unknown look up based on qualifying equipment type in Table 3-80	Btu	

Variable	Description	Value	Units	Ref
$N_{preheat}$	Number of preheats per day	1		
$hrs_{preheat}$	Preheat duration	Look up based on qualifying equipment type in Table 3-84	hours	
$Btu/h_{idle,baseline}$	Baseline Equipment idle energy rate	Look up based on qualifying equipment type in Table 3-79	Btu/h	
$Btu/h_{idle,ee}$	Energy Efficient Equipment idle energy rate	Site-specific, if unknown look up based on qualifying equipment type in Table 3-80	Btu/h	
$(lbs/hr)_{baseline}$	Baseline Equipment production capacity	Look up based on qualifying equipment type in Table 3-79	lbs/hr	
$(lbs/hr)_{ee}$	Energy Efficient Equipment production capacity	Site-specific, if unknown look up based on qualifying equipment type in Table 3-80	lbs/hr	
lbs	Total daily food production	Site-specific, if unknown look up based on qualifying equipment type in Table 3-84	lbs	
Q_{food}	Heat to food	Look up based on qualifying equipment type in Table 3-84	Btu/lb	
$Eff_{baseline}$	Baseline Equipment convection/steam mode cooking efficiency	Look up based on qualifying equipment type in Table 3-79	N/A	
Eff_{ee}	Energy Efficient Equipment convection/steam mode cooking efficiency	Site-specific, if unknown look up based on qualifying equipment type in Table 3-80	N/A	
CF	Electric coincidence factor	Lookup in Table 3-85	N/A	[432]
PDF	Gas peak day factor	Lookup in Table 3-85	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-82 Operating Hours

Building Type	Days/Year	Hours/Day
Education – Primary School	180	8
Education -Secondary School	210	11
Education – Community College	237	16
Education – University	192	16
Grocery	364	16
Medical – Hospital	364	24
Medical – Clinic	351	12
Lodging Motel	364	24
Office – Large	234	12
Office – Small	234	12
Restaurant – Sit-Down	364	12
Restaurant – Fast-Food	364	17
Average = Miscellaneous	288	15

Table 3-83 contains values and simplified calculations for $\Delta Btu_{preheat}$, ΔBtu_{idle} and $\Delta Btu_{cooking}$ terms that may be used in the formulation of estimated savings in lieu of utilizing the calculations prescribed above for these terms. These values were established by performing those calculations using assumed values from the Common Variables, Baseline Efficiencies, and Compliance Efficiency sections.

Table 3-83 Default Values

Equipment	$\Delta Btu_{preheat}$	ΔBtu_{idle}	$\Delta Btu_{cooking}$
Convection Oven, Electric, Full Size	1,706	853 x hrs - 2395	2,317
Convection Oven, Electric, Half Size	341	819 x hrs - 2895	2,317
Convection Oven, Gas, Full Size	8,000	2651 x hrs - 6404	5,328
Convection Oven, Gas, Half Size	5,500	7707 x hrs - 20493	36,164
Conveyor Oven, Gas	6,270	15000 x hrs - 47315	55,072
Rack Oven, Gas, Double Rack	15,000	5400 x hrs - 40353	38,736
Rack Oven, Gas, Single Rack	6,000	5267 x hrs - 32553	17,279
Steamer, Electric[79]	0	1740 x hrs - 3201	6,000
Steamer, Gas[80]	11,000	11279 x hrs - 10783	5,291
Fryer, Electric, Standard	1,706	1085 x hrs - 3229	7,456

[79] Assumes 6 pans
[80] Assumes 6 pans

Equipment	$\Delta Btu_{preheat}$	ΔBtu_{idle}	$\Delta Btu_{cooking}$
Fryer, Gas, Standard	2,500	1429 x hrs - 5906	6,577
Griddle, Electric[81]	6,141	2190 x hrs - 11611	15,833
Griddle, Gas[82]	6,000	8592 x hrs - 60262	55,072

Table 3-84 Common Variables

Equipment	$hrs_{preheat}$	lbs	Q_{food}(Btu/lb)	Ref
Convection Oven, Electric, Full Size	0.25	100	250	[416]
Convection Oven, Electric, Half Size	0.25	100	250	[416]
Convection Oven, Gas, Full Size	0.25	100	250	[416]
Convection Oven, Gas, Half Size	0.25	100	250	[416]
Conveyor Oven, Gas	0.25	190	250	[417]
Rack Oven, Gas, Double Rack	0.33	1200	235	[418]
Rack Oven, Gas, Single Rack	0.33	600	235	[418]
Steamer, Electric	0.25	100	105	[418]
Steamer, Gas	0.25	100	105	[419]
Fryer, Electric, Standard	0.25	150	570	[420]
Fryer, Gas, Standard	0.25	150	570	[420]
Griddle, Electric	0.25	100	475	[421]
Griddle, Gas	0.25	100	475	[421]

Peak Factors

Table 3-85 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.9	[432]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 12 years[83].

[81] Assumes 3-foot griddle width, 2-foot griddle depth
[82] Assumes 3-foot griddle width, 2-foot griddle depth
[83] Shared assumption from all PG&E Work Papers referenced in this measure

References

[411] ENERGY STAR® Commercial Food Service Calculator, https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products

[412] ENERGY STAR® Program Requirements Product Specification for Commercial Ovens, Eligibility Criteria Version 2.2, October 2015, https://www.energystar.gov/sites/default/files/Commercial%20Ovens%20Final%20Version%202.2%20Specification_0.pdf

[413] ENERGY STAR® Program Requirements Product Specification for Commercial Steam Cookers, Eligibility Criteria Version 1.2, August 2003, https://www.energystar.gov/sites/default/files/specs//private/Commercial_Steam_Cookers_Program_Requirements%20v1_2.pdf

[414] ENERGY STAR® Program Requirements Product Specification for Commercial Fryers, Eligibility Criteria Final Draft Version 3.0, October 2016, https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Commercial%20Fryers%20Version%203.0%20%28Rev.%20December%20-%202020%29%20Specification.pdf

[415] ENERGY STAR® Program Requirements Product Specification for Commercial Griddles, Eligibility Criteria Version 1.2, August 2009, https://www.energystar.gov/sites/default/files/Commercial%20Griddles%20Version%201.2%20%28Rev%20December%20-%202020%29.pdf

[416] Pacific Gas & Electric Company, Work Paper PGECOFST101 Commercial Convection Oven-Electric and Gas, Revision 6, August 2016

[417] Pacific Gas & Electric Company, Work Paper PGECOFST117 Commercial Conveyor Oven-Gas, Revision 5, May 2014

[418] Pacific Gas & Electric Company, Work Paper PGECOFST109 Commercial Rack Oven-Gas, Revision 1, October 2018

[419] Pacific Gas & Electric Company, Work Paper PGECOFST104 Commercial Steam Cooker-Electric and Gas, Revision 6, June 2016

[420] Pacific Gas & Electric Company, Work Paper PGECOFST102 Commercial Fryer-Electric and Gas, Revision 6, June 2016

[421] California Technical Forum, Work Paper SWFS004, Commercial Griddle-Electric and Gas, Revision 1, January 2020, available at http://deeresources.net/workpapers

[422] Food Service Technology Center: Gas Rack Oven Life-Cycle Cost Calculator, https://caenergywise.com/calculators/natural-gas-rack-ovens/#calc

[423] Food Service Technology Center: Electric Fryer Life-Cycle Cost Calculator, https://caenergywise.com/calculators/electric-fryers/#calc

[424] Food Service Technology Center: Gas Fryer Life-Cycle Cost Calculator, https://caenergywise.com/calculators/natural-gas-fryers/#calc

[425] California Energy Commission, Energy Research and Development Division, Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Foodservice Equipment, October 2014, http://www.energy.ca.gov/2014publications/CEC-500-2014-095/CEC-500-2014-095.pdf

[426] California Public Utilities Commission, SWFS008, Conveyor Oven, Gas, Commercial, Revision 1, January 2020 available at Ex Ante Database Archive (deeresources.net)

[427] ENERGY STAR® Program Requirements Product Specification for Commercial Fryers, Eligibility Criteria Final Draft Version 2.0, October 2016,

https://www.energystar.gov/ia/partners/prod_development/revisions/downloads/commercial_fryers/Final_Version_2.0_Commercial_Fryer_Specification.pdf?6f81-cd61

[428] California Public Utilies Commission, SWFS001 Commercial Covection Oven – Electric and Gas, Revision 2, May 2020 available at Ex Ante Database Archive (deeresources.net)

[429] California Public Utilies Commission, SWFS014 Rack Oven, Revision 2, May 2020 available at Ex Ante Database Archive (deeresources.net)

[430] California Public Utilies Commission, SWFS005 Commercial Steam Cooker, Revision 2, May 2020 available at Ex Ante Database Archive (deeresources.net)

[431] California Public Utilies Commission, SWFS011 Fryer,Commercial, Revision 4, March 2022 available at Ex Ante Database Archive (deeresources.net)

[432] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs v10, effective date January 1, 2023.

3.4.2 HOLDING CABINETS

Market	Commercial
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

This measure covers the installation of ENERGY STAR® qualified electric commercial hot food holding cabinets. A food holding cabinet is a fully enclosed compartment designed to maintain the temperature of hot food that has been cooked in a separate appliance. Half-size, full-size, and large-size holding cabinets are included in this measure. Half-size holding cabinets are defined as any holding cabinet with an internal measured volume of less than 13 ft^3. Full-size holding cabinets are defined as any holding cabinet with an internal measured volume of greater than or equal to 13 ft^3 and less than or equal to 28 ft^3. Large-size holding cabinets are defined as any holding cabinet with an internal measure volume of greater than 28 ft^3. This measure does not include cook-and-hold or re-therm equipment.

Baseline Case

The baseline condition is an insulated holding cabinet as defined in the Measure Description above with operating characteristics per Table 3-86.

Efficient Case

The compliance condition is ENERGY STAR® food service equipment as defined in the Measure Description above. Operating characteristics shall be taken from application. When unavailable, default characteristics shall be taken from the Summary of Variables and Data Sources table below. Savings for this measure can be claimed only if there is an increase in the qualifying efficiency from the baseline condition.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = hrs \times days \times \frac{\Delta \mathrm{W_{idle}}}{1{,}000}$$

Where,

$$\Delta W_{idle} = W_{idle,b} - W_{idle,q}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{hrs \times days} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-86 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔW_{idle}	Daily idle energy savings	Calculated	Watt	
Hrs	Daily operating hours	Site-specific. If unknown, use 15	Hours/day	[435]
Days	Operating days per year	Site-specific. If unknown, look up in Table 3-87	Days/yr	[434]
1,000	Conversion factor, one kW equals 1,000 watts	1,000	Watts	
$W_{idle,b}$	Baseline equipment idle energy rate by volume	Look up in Table 3-88	Watts	[436]
$W_{idle,q}$	Energy efficient equipment idle energy rate by volume	Site-specific	Watts	
V	Volume of holding cabinet	Site-specific. If unknown, look up in Table 3-88	ft^3	[437]
CF	Electric coincidence factor	Look up in Table 3-89	N/A	
PDF	Gas peak day factor	Look up in Table 3-89	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-87 Operating Days per Year

Building Type	Operating Days per Year
Assembly	355
Auto	355
Big Box	355
Community College	284
Dormitory	355
Fast Food	355
Full Service Restaurant	303
Grocery	365
Hospital	365
Hotel	365
Large Office	303
Light Industrial	251
Motel	365
Multi-story Retail	355
Primary School	218
Religious	355
Secondary School	218
Small Office	303
Small Retail	355
University	284
Warehouse	251

Table 3-88 Default Values

Equipment	$W_{idle,b}$	V
Insulated Holding Cabinet, Large-Size (28 ≤ V)	3.8v + 203.5	35
Insulated Holding Cabinet, Full-Size (13 ≤ V < 28)	2v + 254	25
Insulated Holding Cabinet, Half-Size (0 < V < 13)	21.5v	10

Peak Factors

Table 3-89 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.9	[435]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 12 years [433].

References

[433] DEER 2014 EUL IDs: Various. http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

[434] California Energy Commission, Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Foodservice Equipment, Appendix E.

[435] PG&E Work Paper PGECOFST105 Revision 5, pg. 7. Available to download at http://deeresources.net/workpapers

[436] ENERGY STAR® Program Requirements for Commercial Hot Food Holding Cabinets, Eligibility Criteria Version 2.0, July 2011, where v is holding cabinet volume (ft^3). https://www.energystar.gov/sites/default/files/asset/document/Commercial_HFHC_Program_Requirements_2.0.pdf#:~:text=ENERGY%20STAR%C2%AE%20Program%20Requirements%20Product%20Specification%20for%20Commercial,has%20also%20been%20changed%20from%202010%20to%202011.

[437] PG&E Work Paper PGECOFST105 Revision 5, Table 6, pg. 5.

3.4.3 DISHWASHERS

Market	Commercial
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

This measure describes the installation of ENERGY STAR qualified, high-efficiency stationary and conveyor-type commercial dishwashers used in commercial kitchen establishments that use non-disposable dishes, glassware, and utensils. Commercial dishwashers can clean and sanitize a large quantity of kitchenware in a short amount of time by utilizing hot water, soap, rinse chemicals, and significant amounts of energy. ENERGY STAR qualified models use less water and have lower idling rates than non-ENERGY STAR rated models.

The savings derived below are heavily dependent on the assumed dishwasher hours of operation, which are consistent with a high-usage restaurant or cafeteria operation. If dishwashers are found to be installed in applications with significantly different hours of operation, the hours and savings shall be revised in a custom calculation.

This measure is not applicable to flight machines, which are continuous conveyor machines built specifically for large institutions.

Baseline Case

This is defined as a time of sale measure. The baseline condition is a commercial dishwasher meeting ENERGY STAR Version 2.0 requirements.[438]

Efficient Case

The efficient condition is a high-efficiency commercial dishwasher meeting ENERGY STAR Version 3.0 requirements. [439]

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{WaterHeater} + \Delta kWh_{BoosterHeater} + \Delta kWh_{Idle}$$

Where,

$$\Delta kWh_{WaterHeater} = (WU_b - WU_q) \times RW \times Days \times \frac{\Delta T_{in} \times 1.0 \times 8.2}{RE \times 3{,}412}$$

$$\Delta kWh_{BoosterHeater} = (WU_b - WU_q) \times RW \times Days \times \frac{\Delta T_{in} \times 1.0 \times 8.2}{RE \times 3{,}412}$$

$$\Delta kWh_{Idle} = \left(kW_b \times Days \times \left(HD - \frac{RW \times WT}{60}\right)\right) - \left(kW_q \times Days \times \left(HD - \frac{RW \times WT}{60}\right)\right)$$

Annual Fuel Savings

$$\Delta Therms = \Delta Therms_{WaterHeater} = \left(WU_b - WU_q\right) \times RW \times Days \times \frac{\Delta T_{in} \times 1.0 \times 8.2}{RE \times 100{,}000}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta \text{kWh} \times \frac{CF}{HD \times Days}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-90 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta kWh_{WaterHeater}$	Annual water heater electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{BoosterHeater}$	Annual booster heater electric energy savings	Calculated	kWh/yr	
ΔkWh_{Idle}	Annual dishwasher idle electric energy savings	Calculated	kWh/yr	
WU_q	Water use per rack of qualifying dishwasher, varies by machine type and sanitation method	Site-specific	Gallons	
kW_q	Idle power draw of ENERGY STAR 3.0 dishwasher, varies by machine type and sanitation method	Site-specific	kW	

Variable	Description	Value	Units	Ref
Days	Annual days of dishwasher consumption per year	Site-specific, if unknown use 365	Days/Year	[438]
WU_b	Water use per rack of baseline dishwasher, varies by machine type and sanitation method	Look up in Table 3-91	Gallons	[439]
RW	Number of racks washed per day, varies by machine type and sanitation method	Look up in Table 3-91	Racks Washed/Day	[438]
ΔT_{in}	Temperature rise in water delivered by building water heater or booster water heater, value varies by type of water heater source	Building WH = 70 Booster WH = 40	°F	[438]
RE	Recovery efficiency of water heater	Site-specific, if unknown use 0.98 for electric and 0.80 for gas		[438]
kW_b	Idle power draw of baseline dishwasher, varies by machine type and sanitation method	Look up in Table 3-91	kW	[439]
HD	Hours per day of dishwasher operation	Site-specific, if unknown use 18 hours/day	Hours/Day	[438]
WT	Wash time per dishwasher, varies by machine type and sanitation method	Look up in Table 3-91	Minutes	[438]
$H2O_b$	Annual water consumption of baseline unit	Look up in Table 3-92	gallons	[438]
$H2O_q$	Annual water consumption of efficient unit	Look up in Table 3-92	gallons	[438]
8.2	Density of Water	8.2	Lbs/gal	[440]
60	Conversion factor	60	Min/hr	
3,412	Conversion factor	3,412	Btu/kWh	
1.0	Conversion factor	1.0	Btu/lb-°F	
100,000	Conversion factor	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 3-93	N/A	[441]
PDF	Gas peak day factor	Look up in Table 3-93	N/A	
EUL	Effective useful life	See Measure Life	Years	

Table 3-91 Default Inputs for ENERGY STAR 2.0 Commercial Dishwasher

Machine Type	Temperature	WU_{base}	RW	WT	kW_{base}
Under Counter	Low	1.19	75	2.0	0.50
Stationary Single Tank Door		1.18	280	1.5	0.60
Single Tank Conveyor		0.79	400	0.3	1.50

Machine Type	Temperature	WU_{base}	RW	WT	kW_{base}
Multi Tank Conveyor		0.54	600	0.3	2.00
Under Counter	High	0.86	75	2.0	0.5
Stationary Single Tank Door		0.89	280	1.0	0.7
Single Tank Conveyor		0.70	400	0.3	1.5
Multi Tank Conveyor		0.54	600	0.2	2.25
Pot, Pan, and Utensil		0.58	280	3.0	1.20

Table 3-92 Annual Water Consumption

Machine Type	Temperature	$H2O_b$	$H2O_q$
Under Counter	Low	47,359	32,576
Stationary Single Tank Door		214,620	120,596
Single Tank Conveyor		191,260	115,340
Multi Tank Conveyor		227,760	118,260
Under Counter	High	29,839	23,543
Stationary Single Tank Door		131,838	90,958
Single Tank Conveyor		127,020	102,200
Multi Tank Conveyor		212,430	118,260
Pot, Pan, and Utensil		71,540	59,276

Peak Factors

Table 3-93 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.9	[441]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Non-Energy Impacts

$$\Delta H2O = H2O_b - H2O_q$$

Measure Life

The effective useful life (EUL) is listed in Table 3-94 [438].

Table 3-94 Measure Life

Machine Type	Measure Life (years)
Under Counter	10
Stationary Single Tank Door	15
Single Tank Conveyor	20
Multi Tank Conveyor	20
Pot, Pan, and Utensil	10

References

[438] ENERGY STAR Savings Calculator for Certified Commercial Kitchen Equipment. http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx

[439] ENERGY STAR Program Requirements for Commercial Dishwashers Version 2.0, ENERGY STAR, February 2013.

[440] Dishwasher inlet temperature assumed at 140 degrees F. https://water.usgs.gov/edu/density.html.

[441] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs v10, effective date January 1, 2023.

3.4.4 ICE MACHINES

Market	Commercial
Baseline Condition	TOS/DI
Baseline	Code/Dual
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

This measure covers the installation of ENERGY STAR® qualified ice makers. Ice makers are factory-made assemblies consisting of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice. This measure includes batch-type (cube type) and continuous-type (flake or nugget type) ice makers. Batch-type ice makers have distinct freezing and harvesting periods whereas continuous-type ice makers produce ice through a continuous freezing and harvesting process. Ice makers that have earned the ENERGY STAR® label use approximately 11% less energy and 25% less water than comparable non-qualified models [442].

This measure covers ice making head, remote condensing, and self-contained air-cooled ice makers. Water-cooled ice makers, ice and water dispensing systems, and air-cooled remote condensing units that are designed only for connection to remote rack compressors are not eligible for energy savings.

Baseline Case

TOS: The baseline condition is a commercial ice maker as defined in the Measure Description section above with Equipment Type and Ice Harvest Rate equivalent to the efficient case. Baseline daily energy use per 100 lbs of ice shall be established based on efficient equipment Ice Harvest Rate in accordance with current federal standards for batch type [443] and continuous type [443] ice makers, as specified in the Code of Federal Regulations and provided in Table 3-96.

DI: Use dual baseline. For the remaining useful life of the replaced equipment, the baseline is the site-specific existing unit. For the duration of the measure life of the installed unit, use TOS baseline described above.

Efficient Case

The compliance condition is an ENERGY STAR® version 3.0 qualified commercial ice maker as defined in the Measure Description above. Efficient condition daily energy use per 100 pounds of ice are established based on efficient equipment Ice Harvest Rate in accordance with ENERGY STAR® v. 3.0 maximum qualifying specifications, as shown in Table 3-96 [444]. An efficient ice maker also needs to meet the potable water consumption requirement as shown in Table 3-96 [444].

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times 365 \times Cycle \times \left(\frac{IHR}{100}\right)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta \text{kWh}}{8{,}760 \times \text{Cycle}} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-95 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kWh_b	Baseline electric energy consumption per 100 pounds of ice	Look up in Table 3-96	kWh/lbs	[443]

Variable	Description	Value	Units	Ref
kWh_q	Energy efficient electric energy consumption per 100 pounds of ice	Site-specific. If unknown, look up in Table 3-96	kWh/lbs	[444]
IHR	Rated Ice Harvest Rate of the energy efficient measure	Site-specific	lbs/day	
Cycle	Duty cycle, defined as the ratio of the actual ice harvest rate to the equipment rated ice harvest rate	0.75	N/A	[446]
365	Days per year	365	Days/yr	
100	Factor to convert IHR to units of 100 lbs/day	100	lbs/day	
8,760	Hours in one year	8,760	Hrs/yr	
CF	Electric coincidence factor	Look up in Table 3-97	N/A	[445]
PDF	Gas peak day factor	Look up in Table 3-97	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[447]
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-96 Equipment Type and Ice Harvest Rate

Equipment Type	Ice Harvest Rate (IHR)	Baseline Daily Energy Use per 100 ilbs (kWh_b)	Measure Daily Energy Use per 100 lbs (kWh_q)	Potable Water Use (gal/100 lbs ice)
Batch Type, Ice-Making Head	< 300	10 – 0.01233 x IHR	9.20 – 0.01134 x IHR	≤ 20.0
	≥ 300 and < 800	7.05 – 0.0025 x IHR	6.49 – 0.0023 x IHR	≤ 20.0
	≥ 800 and < 1,500	5.55 – 0.00063 x IHR	5.11 – 0.00058 x IHR	≤ 20.0
	≥ 1,500 and < 4,000	4.61	4.24	≤ 20.0
Batch Type, Remote Condensing	< 988	7.97 – 0.00342 x IHR	7.17 – 0.00308 x IHR	≤ 20.0
	≥ 988 and < 4,000	4.59	4.13	≤ 20.0
Batch Type, Self-Contained	< 110	14.79 – 0.0469 x IHR	12.57 – 0.0399 x IHR	≤ 25.0
	≥ 110 and < 200	12.42 – 0.02533 x IHR	10.56 – 0.0215 x IHR	≤ 25.0
	≥ 200 and < 4,000	7.35	6.25	≤ 25.0
Continuous Type, Ice-Making Head	< 310	9.19 – 0.00629 x IHR	7.90 – 0.005409 x IHR	≤ 15.0
	≥ 310 and < 820	8.23 – 0.0032 x IHR	7.08 – 0.002752 x IHR	≤ 15.0
	≥ 820 and < 4,000	5.61	4.82	≤ 15.0
Continuous Type, Remote Condensing	< 800	9.7 – 0.0058 x IHR	7.76 – 0.00464 x IHR	≤ 15.0
	≥ 800 and < 4,000	5.06	4.05	≤ 15.0
	< 200	14.22 – 0.03 x IHR	12.37 – 0.0261 x IHR	≤ 15.0

Equipment Type	Ice Harvest Rate (IHR)	Baseline Daily Energy Use per 100 ilbs (kWh_b)	Measure Daily Energy Use per 100 lbs (kWh_q)	Potable Water Use (gal/100 lbs ice)
Continuous Type, Self-Contained	≥ 200 and < 700	9.47 – 0.00624 x IHR	8.24 – 0.005429 x IHR	≤ 15.0
	≥ 700 and < 4,000	5.1	4.44	≤ 15.0

Peak Factors

Table 3-97 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.9	[445]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-98 Measure Life

Equipment	EUL	RUL	Ref
Ice Machines	10	3.3	[447]

References

[442] "Commercial Ice Maker Key Product Criteria." n.d. www.energystar.gov. Accessed January 17, 2023. https://www.energystar.gov/products/commercial_food_service_equipment/commercial_ice_makers/key_product_criteria

[443] "10 CFR § 431.136 (c) and (d) - Energy Conservation Standards and Their Effective Dates." n.d. LII / Legal Information Institute. Accessed January 17, 2023. https://www.law.cornell.edu/cfr/text/10/431.136

[444] "ENERGY STAR Program Requirements for Automatic Commercial Ice Makers -Partner Commitments ENERGY STAR ® Program Requirements for Automatic Commercial Ice Makers Partner Commitments." n.d. Accessed January 17, 2023. https://www.energystar.gov/sites/default/files/Final%20V3.0%20ACIM%20Specification%205-17-17_1.pdf

[445] Pacific Gas & Electric Work Paper SWFS SWFS006-01 Commercial Ice Machines, January 2020, pg. 12. www.deeresources.net/workpapers

[446] Pacific Gas & Electric Work Paper SWFS SWFS006-01 Commercial Ice Machines, January 2020, pg. 9. www.deeresources.net/workpapers

[447] Pacific Gas & Electric Work Paper SWFS SWFS006-01 Commercial Ice Machines, January 2020, pg. 11. www.deeresources.net/workpapers

3.5 HVAC

3.5.1 CENTRAL AC, AIR SOURCE HEAT PUMPS, MINI-SPLITS, PTAC, PTHP

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This prescriptive measure targets the use of central air conditioners, air source heat pumps, mini split heat pumps, packaged terminal systems (PTAC and PTHP) in commercial and multifamily high-rise applications as further described below. This measure may apply to early replacement of an existing system, replacement on burnout, or installation of a new unit in a new or existing commercial or multifamily high-rise building for HVAC applications.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

For whole building new construction, the baseline equipment is an industry standard equipment type for the facility compliant with ASHRAE 90.1-2019 (see Appendix E: Code-Compliant Efficiencies).

For replacement of failed equipment, or end of useful life, the baseline would be a minimally code compliant version of the replaced system type and fuel.

For early replacement projects, use dual baselines:

- For the remaining useful life (RUL) of the existing equipment, the baseline is the actual existing equipment. In the lifetime algorithms section, annual savings for this period are designated as kWh_{ex} and $Therms_{ex}$. If the site specific efficiency of the existing equipment is unknown, use the equipment efficiency from the ASHRAE 90.1 version in force when the equipment was new (if equipment vintage is unknown, use ASHRAE 90.1 2013 efficiency requirements from Appendix E: Code-Compliant Efficiencies).
- For the duration of the measure life after the end of the RUL, the baseline is a code-compliant version of the replaced equipment. In the lifetime algorithms section, annual savings for this period are designated as kWh_{TOS} and $Therms_{TOS}$.

Efficient Case

A central air conditioner, air source heat pump, mini split heat pump, or packaged terminal system (PTAC and PTHP) that meets ENERGY STAR Light Commercial HVAC v4.0 criteria [448], or otherwise exceeds ASHRAE 90.1-2019 requirements if not included in ENERGY STAR specification.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

Where,

$$kWh_b = OSF \times kWh_{c,b} + kWh_{h,b}$$

$$kWh_q = OSF \times kWh_{c,q} + kWh_{h,q}$$

Calculate $kWh_{c,b}$ and $kWh_{h,b}$ using the algorithms in Table 3-99 for the appropriate baseline equipment type.

Calculate $kWh_{c,q}$ and $kWh_{h,q}$ using the algorithms in Table 3-100 for the appropriate efficient equipment type.

Note:

- Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.
- The oversize derating factor (OSF) in the equations above is applicable for heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. The appropriate OSF should be determined from site-specific conditions if possible, otherwise use the default values provided below.

Table 3-99 Baseline Energy Consumption Equations

Baseline Equipment	Baseline Cooling kWh ($kWh_{c,b}$)	Baseline Heating kWh ($kWh_{h,b}$)
Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$
ASHP (Cooling Capacity > 65 kBtu/h & IEER Available)	$\frac{Cap_c}{IEER_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$
ASHP (Cooling Capacity > 65 kBtu/h & IEER not available)	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$
Air Conditioner (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	0
Air Conditioner (Cooling Capacity > 65 kBtu/h & IEER Available)	$\frac{Cap_c}{IEER_b \times 1{,}000} \times EFLH_c$	0

Baseline Equipment	Baseline Cooling kWh ($kWh_{c,b}$)	Baseline Heating kWh ($kWh_{h,b}$)
Air Conditioner (Cooling Capacity > 65 kBtu/h & IEER not available)	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	0
PTAC	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	0
PTHP	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_\mathrm{h}$
Electric Resistance heating	0	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_\mathrm{h}$
Room Air Conditioner	$\frac{Cap_c}{CEER_b \times 1{,}000} \times EFLH_c$	0

Table 3-100 Energy Efficient Energy Consumption Equations

Qualifying Equipment	Efficient Cooling kWh ($kWh_{c,q}$)	Efficient Heating kWh ($kWh_{h,q}$)
Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_q \times 1{,}000} \times EFLH_\mathrm{h}$
ASHP (Cooling Capacity > 65 kBtu/h & IEER Available)	$\frac{Cap_c}{IEER_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_\mathrm{h}$
ASHP (Cooling Capacity > 65 kBtu/h & IEER not available)	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_\mathrm{h}$
Central Air Conditioner (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_q \times 1{,}000} \times EFLH_c$	0
Central Air Conditioner (Cooling Capacity > 65 kBtu/h & IEER Available)	$\frac{Cap_c}{IEER_q \times 1{,}000} \times EFLH_c$	0
Central Air Conditioner (Cooling Capacity > 65 kBtu/h & IEER not available)	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	0
PTAC	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	0
PTHP	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_\mathrm{h}$

Annual Fuel Savings

$$\Delta Therms = Therms_b - Therms_q$$

Where,

$$Therms_b = see \text{ Table 3-101 } for\ appropriate\ baseline\ equipment\ type$$

$$Therms_q = 0$$

Table 3-101 Fuel Savings

Baseline Equipment	Baseline fuel consumption ($Therms_b$)
ASHP	0
Gas Fired Furnace/Boiler	$\frac{Cap_h}{Eff_{b,fuel} \times 100{,}000} \times EFLH_h$
Electric resistance heating	0

Peak Demand Savings

$$\Delta kW_{Peak} = Cap_c \times \frac{1}{1{,}000} \times \left(\frac{1}{EER2_b} - \frac{1}{EER2_q}\right) \times CF_c$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-102 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	

Variable	Description	Value	Units	Ref
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_b	Baseline electrical consumption	Calculated	kWh/yr	
kWh_q	Energy efficient electrical consumption	Calculated	kWh/yr	
Cap_c	Cooling capacity of installed unit	Site-specific	Btu/hr	
Cap_h	Heating capacity of qualifying unit	Site-specific	Btu/hr	
$SEER2_q$	SEER2 of qualifying unit	Site-specific	Btu/W-h	
$IEER_q$	IEER of qualifying unit	Site-specific	Btu/W-h	
$EER2_q$	EER2 of qualifying unit	Site-specific	Btu/W-h	
COP_q	Coefficient of performance at 47F of the qualifying unit	Site-specific	N/A	
$HSPF_q$	Heating seasonal performance factor of the installed unit	Site-specific	Btu/W-h	
$SEER2_b$	SEER of baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[448][450]
$IEER_b$	IEER of baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[448][450]
$EER2_b$	EER2 of baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[448][450]
$HSPF2_b$	Heating seasonal performance factor of the baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies. For electric resistance heat, use 3.412	Btu/W-h	[448][450]
$CEER_b$	Combined Energy Efficiency Ratio of baseline room air conditioner[84]	Use federal standard values in Appendix E: Code-Compliant Efficiencies. If unknown, use 11.0	Btu/W-h	[454]
$Eff_{b,fuel}$	Efficiency of baseline boiler/furnace	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	N/A	[448][450]
OSF	Oversize derating factor[85]	Site-specific, if unknown use 0.8	N/A	

[84] Default value (11.0) is the CEER value from minimum Federal Standard for the most common room AC type – <8000 capacity range with louvered sides

[85] Heat pump systems may be sized to meet the peak heating load and will be oversized for cooling. The cooling EFLH assumes a nominal 20% oversizing. This derating factor has been added to account for the oversizing of heat pump cooling capacity when the unit is sized based on heating capacity. A user with a more accurate estimation of the oversizing can use a different factor than the one mentioned above to account for oversizing.

Variable	Description	Value	Units	Ref
$kWh_{c,b}$	Baseline cooling electrical consumption	Look up in Table 3-99	kWh/yr	
$kWh_{h,b}$	Baseline heating electrical consumption	Look up in Table 3-99	kWh/yr	
$kWh_{c,q}$	Energy efficient cooling electrical consumption	Look up in Table 3-100	kWh/yr	
$kWh_{h,q}$	Energy efficient heating electrical consumption	Look up in Table 3-100	kWh/yr	
$Therms_b$	Baseline fuel consumption	Look up in Table 3-101	Therms/yr	
$Therms_q$	Energy efficient fuel consumption	0	Therms/yr	
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	[451]
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Lookup in Appendix C: Heating and Cooling EFLH	Hours	[451]
COP_b	Coefficient of performance at 47F of the baseline unit	Look up in Appendix E: Code-Compliant Efficiencies	N/A	[448][450]
1,000	Conversion from hp to Kw	1,000	w/kW	
3.412	Conversion factor from kWh to kBtu	3.412	kBtu/kWh	
CF	Cooling coincidence factor	Look up in Table 3-103	N/A	[452]
PDF	Gas peak day factor	Look up in Table 3-103	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[453]

Peak Factors

Table 3-103 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.5	[452]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-104 Measure Life

Equipment	EUL	RUL	Ref
Central A/C	15	5	[453]
Air source heat pump	15	5	[453]
Mini split heat pump	15	5	[453]
PTAC/PTHP	15	5	[453]

References

[448] ENERGY STAR Light Commercial HVAC Version 4.0, https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20LC%20HVAC%20Version%204.0%20Specification%20Rev%20April%202022.pdf?_gl=1*n9oet2*_ga*MTUwMjg5MDYyNC4xNjY0NDc5NDA0*_ga_S0KJTVVLQ6*MTY4MDU0NjcxNi4zNS4xLjE2ODA1NDY5NjAuMC4wLjA

[449] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[450] ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[451] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[452] C&I Unitary HVAC Load Shape Project Final Report. August 2011, v.1.1, p. 12, Table O-5. The CF reported here is a center point for NJ chosen between the CF for urban NY and for the Mid-Atlantic region in the PJM peak periods.

[453] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[454] Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430, Subpart C, section 430.32 b) Room Air Conditioners,

3.5.2 GEOTHERMAL AND WATER SOURCE HEAT PUMPS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2022

Description

This prescriptive measure targets the use of, water to air water loop heat pumps, water to air ground water heat pumps, brine to air ground loop heat pumps, brine to water ground loop heat pumps in commercial and multifamily applications as further described below. This measure may apply to early replacement of an existing system, replacement on burnout, or installation of a new unit in a new or existing commercial or multifamily building for HVAC applications.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

For whole building new construction, the baseline equipment is an air source heat pump (or other instrustry standard equipment type for the facility) compliant with ASHRAE 90.1-2019 (see Appendix E: Code-Compliant Efficiencies).

For replacement of failed equipment, or end of useful life, the baseline would be a minimally code compliant version of the replaced system type and fuel.

For early replacement projects, use dual baselines:

- For the remaining useful life (RUL)of the existing equipment, the baseline is the actual existing equipment. In the lifetime algorithms section, annual savings for this period are designated as kWh_{ex} and $Therms_{ex}$. If the site specific efficiency of the existing equipment is unknown, use the equipment efficiency from the ASHRAE 90.1 version in force when the equipment was new (if equipment vintage is unknown, use ASHRAE 90.1 2013 efficiency requirements from Appendix E: Code-Compliant Efficiencies).
- For the duration of the measure life after the end of the RUL, the baseline is a current code-compliant version of the replaced equipment. In the lifetime algorithms section, annual savings for this period are designated as kWh_{TOS} and $Therms_{TOS}$.
- Note: the algorithms in this section assume that the installed heat pump replaces 100% of the heating and cooling load of the existing equipment. In a partial displacement scenario, the consumption algorithms must be adjusted to account for the actual percent of building load supplied by HVAC equipment.

Efficient Case

A high-efficiency groundwater source, water source, or ground source heat pump system that meets or exceeds code requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

Where,

$$kWh_b = OSF \times kWh_{c,b} + kWh_{h,b} + kWh_{p,b}$$

$$kWh_q = OSF \times kWh_{c,q} + kWh_{h,q} + kWh_{p,q}$$

Calculate kWhc,b, kWhh,b, and kWhp,b using the algorithms in Table 3-105 for the appropriate baseline equipment type.

Calculate kWhc,q, kWhh,q, and kWhp,q using the algorithms in Table 3-106 for the appropriate efficient equipment type.

Note:

- Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.
- The oversize derating factor (OSF) in the equations above is applicable for heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. The appropriate OSF should be determined from site-specific conditions if possible, otherwise use the default values provided below.

Table 3-105 Baseline Energy Consumption Equations

Baseline Equipment	Baseline Cooling kWh ($kWh_{c,b}$)	Baseline Heating kWh ($kWh_{h,b}$)	Baseline Circulating Pump kWh ($kWh_{p,b}$)
ASHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{SEER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$	0
ASHP (Cooling Capacity > 65 kBtu/h & IEER Available)	$\frac{Cap_c}{IEER_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$	0
ASHP (Cooling Capacity > 65 kBtu/h & IEER not available)	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$	0
WSHP	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_b \times LF}{Eff_{motor,b}} \times Hr$
GSHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{GSER \times EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_b \times LF}{Eff_{motor,b}} \times Hr$

Baseline Equipment	Baseline Cooling kWh ($kWh_{c,b}$)	Baseline Heating kWh ($kWh_{h,b}$)	Baseline Circulating Pump kWh ($kWh_{p,b}$)
GSHP (Cooling Capacity > 65 kBtu/h)	$\frac{Cap_c}{EER2_b \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_b \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_b \times LF}{Eff_{motor,b}} \times Hr$
DX A/C	$\frac{Cap_c}{IEER_b \times 1{,}000} \times EFLH_c$	0	0
Electric Resistance heating	0	$\frac{Cap_h}{HSPF2_b \times 1{,}000} \times EFLH_h$	0

Table 3-106 Energy Efficient Energy Consumption Equations

Qualifying Equipment	Efficient Cooling kWh ($kWh_{c,q}$)	Efficient Heating kWh ($kWh_{h,q}$)	Efficient Circulating Pump kWh ($kWh_{p,q}$)
Water to air water loop heat pumps, water to air ground water heat pumps, brine to air ground loop heat pumps, brine to water ground loop heat pumps	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_q \times LF \times ESF_{VFD}}{Eff_{motor,q}} \times Hr$
GSHP (Cooling Capacity < 65 kBtu/h)	$\frac{Cap_c}{GSER \times EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_q \times LF \times ESF_{VFD}}{Eff_{motor,q}} \times Hr$
GSHP (Cooling Capacity > 65 kBtu/h)	$\frac{Cap_c}{EER2_q \times 1{,}000} \times EFLH_c$	$\frac{Cap_h}{COP_q \times 3.412 \times 1{,}000} \times EFLH_h$	$\frac{0.746 \times HP_q \times LF \times ESF_{VFD}}{Eff_{motor,q}} \times Hr$

Annual Fuel Savings

$$\Delta Therms = Therms_b - Therms_q$$

Where,

$$Therms_b = see \text{ Table 3-107 } for\ appropriate\ baseline\ equipment\ type$$

$$Therms_q = 0$$

Table 3-107 Baseline Fuel Consumption

Baseline Equipment	Baseline fuel consumption ($Therms_b$)
ASHP, WSHP, GSHP	0
Gas Fired Furnace/Boiler	$\frac{Cap_h}{Eff_{b,fuel} \times 100{,}000} \times EFLH_h$
Electric resistance heating	0

Peak Demand Savings

$$\Delta kW_{Peak} = kW_{peak,cool} + kW_{peak,pump}$$

Where,

$$\Delta kW_{peak,cool} = Cap_c \times \frac{1}{1{,}000} \times \left(\frac{1}{EER2_b} - \frac{1}{EER2_q}\right) \times CF_c$$

$$\Delta kW_{peak,pump} = 0.746 \times \left\{\left(HP_b \times LF \times \frac{1}{Eff_b}\right) - \left(HP_q \times LF \times \frac{1}{Eff_q} \times DSF_{VFD}\right)\right\} \times CF_{pump}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-108 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	

Variable	Description	Value	Units	Ref
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
kWh_b	Baseline electrical consumption	Calculated	kWh/yr	
kWh_q	Energy efficient electrical consumption	Calculated	kWh/yr	
Cap_c	Cooling capacity of qualifying unit	Site-specific	Btu/hr	
Cap_h	Heating capacity of qualifying unit	Site-specific	Btu/hr	
$EER2_q$	EER2 of qualifying unit	Site-specific	Btu/W-h	
COP_q	Coefficient of performance of the qualifying unit	Site-specific	N/A	
HP_q	Horsepower of qualifying ground/water loop circulating pump motor	Site-specific	HP	
HP_b	Horsepower of base case ground/water loop circulating pump motor	Site-specific, if unknown use HP_q	HP	
$SEER2_b$	SEER2 of baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[461][462]
$IEER_b$	IEER of baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[461][462]
$EER2_b$	EER2 of baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	[461][462]
$HSPF2_b$	Heating seasonal performance factor of the baseline unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies. For electric resistance heat, use 3.412	Btu/W-h	[461][462]
$Eff_{motor,b}$	Efficiency of base case ground/water loop circulating pump motor	Site-specific, if unknown look up in Table 3-109	N/A	[463]
$Eff_{motor,q}$	Efficiency of qualifying ground/water loop circulating pump motor	Site-specific, if unknown look up in Table 3-109	N/A	[463]
$Eff_{b,fuel}$	Efficiency of baseline boiler/furnace	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	N/A	[461][462]
OSF	Oversize derating factor[86]	Site-specific, if unknown use 0.8	N/A	
$kWh_{c,b}$	Baseline cooling electrical consumption	Look up in Table 3-105	kWh/yr	

[86] Heat pump systems are generally sized to meet the peak heating load and are oversized for cooling. The cooling EFLH assumes a nominal 20% oversizing. This derating factor has been added to account for the oversizing of pumps. A user with a more accurate estimation of the oversizing can use a different factor than the one mentioned above to account for oversizing.

Variable	Description	Value	Units	Ref
$kWh_{h,b}$	Baseline heating electrical consumption	Look up in Table 3-105	kWh/yr	
$kWh_{p,b}$	Baseline pump electrical consumption	Look up in Table 3-105	kWh/yr	
$kWh_{c,q}$	Energy efficient cooling electrical consumption	Look up in Table 3-106	kWh/yr	
$kWh_{h,q}$	Energy efficient heating electrical consumption	Look up in Table 3-106	kWh/yr	
$kWh_{p,q}$	Energy efficient pump electrical consumption	Look up in Table 3-106	kWh/yr	
$Therms_b$	Baseline fuel consumption	Look up in Table 3-107	Therms/yr	
$Therms_q$	Energy efficient fuel consumption	0	Therms/yr	
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	See Appendix C: Heating and Cooling EFLH	Hours	[455]
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	See Appendix C: Heating and Cooling EFLH	Hours	[455]
COP_b	Coefficient of performance of the baseline unit	Look up in Appendix E: Code-Compliant Efficiencies	N/A	[461][462]
GSER	Factor used to determine the seasonal efficiency of a GSHP based on its EER	1.02	N/A	[456]
1,000	Conversion from hp to Kw	1,000	w/kW	
3.412	Conversion factor from kWh to kBtu	3.412	kBtu/kWh	
0.746	Conversion from HP to kW	0.746	kW/hp	
LF	Load factor of pump motor	0.75	N/A	[457]
ESF_{VFD}	Energy savings factor to account for variable speed pumping in qualifying unit	If variable speed pump: 0.661 If constant speed: 1.0		[465]
DSF_{VFD}	Demand savings factor to account for variable speed pumping in qualifying unit	If variable speed pump: 0.210 If constant speed: 1.0		[465]
Hrs	Operating hours of pump motor, equal to the sum of $EFLH_c$ and $EFLH_h$	Look up in Appendix D: HVAC Fan and Pump Operating Hours	Hours	
CF_c	Cooling coincidence factor	Look up in Table 3-110	N/A	
CF_{pump}	Pump coincidence factor	Look up in Table 3-110	N/A	
PDF	Gas peak day factor	Look up in Table 3-110	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-109 Federal Baseline Motor Efficiencies

Motor HP	Motor Nominal Full-Load Efficiencies (percent)							
	2 Poles		4 poles		6 Poles		8 Poles	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0

Peak Factors

Table 3-110 Peak Factors

Peak Factor	Value	Ref
Cooling coincidence factor (CF_c)	0.5	[458]
Pump coincidence factor (CF_{pump})	If unit runs 24/7/365, CF=1.0, else use 0.5	[458]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-111 Measure Life

Equipment	EUL	RUL	Ref
Water source Pump	15	5	[460]
Ground source heat pump	25	8.33	[464]

References

[455] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[456] VEIC estimate. Extrapolation of manufacturer data.

[457] *Determining Electric Motor Load and Efficiency*. (DOE, 2014), pg 1, https://www.energy.gov/sites/prod/files/2014/04/f15/10097517.pdf

[458] C&I Unitary HVAC Load Shape Project Final Report. August 2011, v.1.1, p. 12, Table O-5. The CF reported here is a center point for NJ chosen between the CF for urban NY and for the Mid-Atlantic region in the PJM peak periods.

[459] Available at: http://www.neep.org/sites/default/files/resources/NEEP_HVAC_Load_Shape_Report_Final_August2_0.pdf

[460] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[461] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[462] ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[463] *§ CFR431.25 Energy conservation standards and effective dates*, (2023) Table 1, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-B/subject-group-ECFR03b7039d87b7cc6/section-431.25

[464] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1

[465] See section 3.8.2 VFD

3.5.3 INFRARED HEATER

Market	Commercial/Multifamily
Baseline Condition	NC/TOS/DI
Baseline	Code/Dual
End Use Subcategory	Gas Space Heating Equipment
Measure Last Reviewed	November 2022

Description

This measure outlines the savings for the installation of a gas-fired, low intensity infrared (IR) heating system in place of a unit heater, furnace, or other standard efficiency equipment in commercial and industrial facilities.

Savings are based on the reduced input capacity requirement with the radiant heating of an IR Heater (efficient) as opposed to convective heating of a conventional heating system (baseline). The thermal efficiency is assumed to be equivalent between the baseline and efficient case.

The algorithms do not include potential savings as a result of a few baseline assumptions. For example, if the baseline is assumed to be a furnace, there will be kwh savings associated with reduction in fan energy reduction.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Code-compliant furnace, unit heater, or other standard efficiency equipment. For new construction, a gas-fired warm unit heater shall be assumed.

Efficient Case

The efficient case condition is a low-intensity, gas-fired infrared heater. The prescribed methodology assumes a reduction of 10°F to maintain occupant comfort. [468]

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = Cap_{in} * \left(1 - \frac{HDD_{55}/(55 - T_{design})}{HDD_{65}/(65 - T_{design})}\right) * \frac{EFLH_h}{100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-112 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
Cap_{in}	Input capacity of qualifying unit	Site-specific	kBtu/hr	
HDD_{55}	Heating degree days: number of degrees the average daily temperature is below 55°F	Look up in Table 3-113	°F-day	[466]
HDD_{65}	Heating degree days: number of degrees the average daily temperature is below 65°F	Look up in Table 3-113	°F-day	[466]
T_{design}	Equipment design temperature	Look up in Table 3-113	°F	[469]

Variable	Description	Value	Units	Ref
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	See Appendix C: Heating and Cooling EFLH	hour/yr	[467]
100	Conversion from kBtu to therms	100	kBtu/therms	
CF	Electric coincidence factor	Look up in Table 3-114	N/A	
PDF	Gas peak day factor	Look up in Table 3-114	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-113 Heating Degree Days and Equipment Design Temperature

Climate Zone	HDD_{65}	HDD_{55}	T_{design}
Northern	6,136	3,759	8.1
Central	5,588	3,331	11.6
Pine Barrens	5,529	3,294	10.5
Southwest	5,658	3,418	13.8
Coastal	4,795	2,573	11.6
Statewide Average	5,555	3,288	11.1

Peak Factors

Table 3-114 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Table 3-115 Measure Life

Equipment	EUL	RUL	Ref
Infrared Heater	17	5.7	[471]

References

[466] TMY3 data for NJ climate zone representative cities: Northern – Allentown, PA; Central – Trenton, NJ; Pine Barrens – McGuire AFB NJ; Southwest – Philadelphia, PA International Airport; Coastal – Atlantic City, NJ.

[467] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[468] 2012 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 16, Infrared Radiant Heating.

[469] ASHRAE Fundamentals 2021, Chapter 14 Climactic Design Conditions, https://handbook.ashrae.org/Handbook.aspx#. Based on NJ climate zone representative cities: Northern – Allentown, PA; Central – Trenton, NJ; Pine Barrens – McGuire AFB NJ; Southwest – Philadelphia, PA International Airport; Coastal – Atlantic City, NJ.

[470] GDS Associates, Inc. "Natural Gas Efficiency Potential Study." DTE Energy. July 29, 2016. Available from: https://www.michigan.gov/documents/mpsc/DTE_2016_NG_ee_potential_study_w_appendices_vFINAL_554360_7.pdf

[471] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

3.5.4 FURNACES, UNIT HEATERS AND BOILERS

Market	Commercial/Multifamily
Baseline Condition	NC/TOS/DI/EREP
Baseline	Code/ISP/Dual
End Use Subcategory	Gas Space Heating Equipment
Measure Last Reviewed	November 2022

Description

This measure encourages the installation of high-efficiency, natural gas-fired furnaces, unit heaters and closed loop space heating boilers meeting program eligibility requirements. Equipment sizing assumes compliance with ASHRAE 90.1 - 2019 sizing requirements.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

For NC and TOS programs, , the baseline unit is a code compliant unit of the same type and size as the installed unit with efficiency as required by ASHRAE Std. 90.1 – 2019 and IECC 2021, which are the current codes adopted by the State of New Jersey (see Appendix E: Code-Compliant Efficiencies). For New Construction, an Industry Standard Practice baseline which is 15% more efficient than Code applies to furnaces.

For early replacement projects, use dual baselines:

- For the remaining useful life of the existing equipment, the baseline is the actual existing equipment if the site specific efficiency of the existing equipment is unknown, use the ASHRAE 90.1-2013 efficiency for the existing equipment type (see Appendix E: Code-Compliant Efficiencies).
- For the duration of the measure life, the baseline is a code-compliant unit of the same type and size of the installed unit with efficiency as required by ASHRAE Std. 90.1 – 2019 and IECC 2021 (see Appendix E: Code-Compliant Efficiencies).

Efficient Case

Equipment with an efficiency higher than Code or ISP that meets program eligibility requirements. No size limits on furnaces or unit heaters.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

Where,

$$kWh_b = \frac{Cap_h}{HSPF_b \times 1{,}000} \times EFLH_h\ (Electric\ Resistance\ Baseline)$$

$$kWh_b = 0\ (Gas\ Equipment\ Baseline)$$

$$kWh_q = 0$$

Annual Fuel Savings

$$\Delta Therms = Therms_b - Therms_q$$

Where,

$$Therms_b = \frac{Cap_{in}}{Eff_{AF} \times Eff_b \times 100{,}000} \times EFLH_h\ (Gas\ Equipment\ Baseline)$$

$$Therms_b = 0\ (Electric\ Baseline)$$

$$Therms_q = \frac{Cap_h}{Eff_q \times 100{,}000} \times EFLH_h$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-116 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Lifetime}$	Lifetime fuel savings	Calculated	Therms	
Cap_{in}	Input capacity of qualifying unit	Site-specific	Btu/hr	
Eff_q	Equipment Proposed Efficiency	Site-specific	Varies	
$HSPF_b$	Heating seasonal performance factor of baseline electric unit	Site-specific or look up in Appendix E: Code-Compliant Efficiencies		
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Look up in Appendix C: Heating and Cooling EFLH	Hrs/yr	[472]
Eff_b	Gas equipment baseline efficiency	Look up in Table 3-117	Varies	[473][474]
Eff_{AF}	Equipment baseline efficiency ISP adjustment Factor	1.15 (New Construction furnaces only) 1.0 (all others)	N/A	[475]
1,000	Conversion factor	1,000	Watts/kW	
100,000	Conversion factor	100,000	Btu/Therm	
CF	Electric coincidence factor	Look up in Table 3-118 Peak Factors	N/A	
PDF	Gas peak day factor	Look up in Table 3-118 Peak Factors	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-117 Baseline Efficiencies

Equipment	Type	Size Category (kBtu input)	ASHRAE Standard 90.1-2019 Efficiency
Furnace	Gas Fired	< 225	Nonweatherized 80% AFUE Weatherized 81% AFUE or 80% Et

Equipment	Type	Size Category (kBtu input)	ASHRAE Standard 90.1-2019 Efficiency
	Gas Fired	≥ 225	81% Et
	Oil Fired	< 225	Nonweatherized excluding mobile home 83% AFUE Nonweatherized mobile home 75% AFUE Weatherized 78% AFUE
	Oil Fired	≥ 225	82% Et
Unit Heater	Gas Fired, Oil Fired	All Capacities	80% Ec
Hot Water Boiler	Gas Fired	<300	82% AFUE
		≥300 and ≤ 2,500	80% Et
		>2,500	82% Ec
	Oil Fired	<300	84% AFUE
		≥300 and ≤ 2,500	82% Et
		>2,500	84% Ec
Steam Boiler	Gas Fired	<300	82% AFUE
	Gas Fired All Except Natural Draft	≥300 and ≤ 2,500	79% Et
		>2,500	79% Et
	Gas Fired Natural Draft	≥300 and ≤ 2,500	79% Et
		>2,500	79% Et
	Oil Fired	<300	85% AFUE
		≥300 and ≤ 2,500	81% Et
		>2,500	81% Et

Peak Factors

Table 3-118 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-119 Measure Life

Equipment	EUL	RUL	Ref
Furnace	20	6.67	[476]
Unit Heater	18	6	[477]
Boiler	20	6.67	[476]
Electric Resistance Heating	20	6.67	[478]

References

[472] Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[473] *ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings*. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[474] *2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES* (IECC 2021), Table C403.3.2(5) https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency

[475] *New Jersey Commercial New Construction Industry Standard Practice Analysis.* Prepared for Rutgers University by DNV. June 2022.

[476] California Database of Energy Efficient Resources (DEER) http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

[477] Ecotope, *Natural Gas Efficiency and Conservation Measure Resource Assessment*, 2003, section 5.2.3, https://ecotope-publications-database.ecotope.com/2003_007_NaturalGasEfficiency.pdf

[478] *Energy Saver 101: Everything you need to know about Home Heating* https://www.energy.gov/sites/prod/files/2014/01/f6/homeHeating.pdf

3.5.5 BOILER CONTROLS

Market	Commercial/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	November 2022

Description

Boiler reset controls automatically adjust the boiler water temperature based on the outdoor air temperature. Boiler cut-out controls use sensors to determine when outside air has reached a specific temperature and turn off the boiler and its connected heating system. Optionally, a timer to control when heating equipment comes on and when it goes off may also be included. These controls are most often installed together using controls that accomplish both functions.

This measure is limited to cut-out controls on non-condensing boilers since boiler reset savings is minimal for non-condensing boilers. Both boiler reset and cut-out controls are applicable to condensing boilers.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Existing boiler without controls.

Efficient Case

Installation of boiler reset and/or cut-out controls. The system's minimum temperature setpoint must be set no more than 10 degrees above manufacturer's recommended minimum return temperature.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = SF \times \frac{EFLH_h \times Cap_{in}}{100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = N/A$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-120 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
SF	Savings Factor: estimated percent reduction in heating load due to controls being installed.	Lookup in Table 3-121	%	[479] [480]
$EFLH_h$	Equivalent full load hours for heating	Look up in Appendix C:	hrs	[481]
Cap_{in}	Input capacity of boiler	Site-specific	kBtu/hr	
EUL	Effective useful life	See Measure Life Section	yrs	
100	Conversion from kBtu to therm	100	kBtu	

Table 3-121 Savings Percentage

Control Type	Savings	Ref
Boiler Reset	5.0%	[479]
Boiler Cut-Out	1.7%	[480]
Boiler Reset & Cut-Out	5%	

Peak Factors

Table 3-122 Peak Factors

Peak Factor	Value	Ref
Coincidence Factor (CF)	N/A	
Natural gas peak day factor (PDF)	Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) of boiler controls is limited to the smaller of the measure life or the remaining useful life (RUL) of the boiler. If boiler RUL unknown, assume 1/3 of the boiler EUL.

Table 3-123 Measure Life

Equipment	EUL	RUL	Ref
Boiler Controls	Smaller of: boiler RUL or 7.33	N/A	
Boiler (steel water-tube)	22	7.33	[482]
Boiler (steel fire-tube)	25	8.33	[482]
Boiler (cast iron)	35	11.67	[482]

References

[479] GDS Associates, Inc. Natural Gas Energy Efficiency Potential in Massachusetts, 2009, p. 38 Table 6-4. https://ma-eeac.org/wp-content/uploads/5_Natural-Gas-EE-Potenial-in-MA.pdf

[480] Arkansas Technical Reference Manual, Version 9.1, Volume 2, page 223 , https://apsc.arkansas.gov/wp-content/uploads/AR_TRM_V9.1_Volume_1_2_and_3_on_8-31-22.pdf

[481] Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.

[482] ASHRAE Handbook 2019, HVAC Applications. Chapter 38 *Owning and Operating Costs*, Table 4.

3.5.6 BOILER ECONOMIZER

Market	Commercial/Multifamily
Baseline Condition	NC/RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	November 2022

Description

This measure covers the installation of a boiler economizer, also known as stack economizers and feedwater economizers. Boiler economizers are designed to recover heat from hot flue gases which is then used to pre-heat boiler feedwater thereby reducing heating requirements. Condensing and conventional non-condensing economizers are the two principal types of boiler economizers.

Non-condensing or conventional economizers are typically air-to-water heat exchangers and operate above the flue gas dew point to avoid condensation [483].

Condensing economizers allow condensing of the exhaust gas components and reduce the flue gas temperature below its dew point. This results in latent heat being recaptured, thereby improving the effectiveness of waste heat recovery [485].

This measure is applicable to the installation of condensing and non-condensing economizers on boilers serving space heating loads and process loads and is restricted to non-condensing, forced draft burner boilers.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline condition is a non-condensing, forced draft burner boiler serving space heating or process loads without a boiler economizer.

Efficient Case

The compliance condition is a non-condensing, forced draft burner boiler serving space heating or process loads with a non-condensing or condensing boiler economizer.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

Economizer for Boilers Serving HVAC Loads:

$$\Delta Therms = Cap_{in} \times \frac{ESF \times EFLH_h}{100}$$

Where,

$$ESF = \frac{T_b - T_q}{40} \times TRE$$

Economizer for Boilers Serving Process Loads:

$$\Delta Therms = Cap_{in} \times \frac{ESF \times 8{,}766 \times UF}{100}$$

Where,

$$ESF = \frac{T_b - T_q}{40} \times TRE$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = N/A$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-124 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	

Variable	Description	Value	Units	Ref
ESF	Energy Savings Factor	Calculated	N/A	[486]
Cap_{in}	Input capacity of qualifying unit	Site-specific	kBtu/hr	
T_b	Baseline full-fire boiler flue gas temperature as it exits the stack	Site-specific. If unknown, use the default of 420°F for hot water boilers and 500°F for steam boilers[87]	°F	[487]
T_q	Energy efficient full-fire boiler flue gas temperature as it exits the stack	Site-specific. If unknown, look up in Table 3-125	°F	[484]
TRE	Temperature Reduction Efficiency; percentage efficiency increases for stack temperature reduction, per 40ºF reduction in net stack temperature	Site-specific. If unknown, use a default of 0.01	N/A	[486]
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	Look up in Appendix C:	Hrs/yr	[487]
100	Conversion from kBtu to therms	100	kBtu/Therms	
40	Stepped reduction in net stack temperature, in ºF	40	°F	
8,766	Process load boiler operating hours	8,766	Hrs/yr	[490]
UF	Utilization factor	0.419	N/A	[490]
PDF	Gas peak day savings factor	Look up in Table 3-126	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-125 Energy Efficient Boiler Flue Gas Temperature

Equipment Type	Conventional Economizer[88,89]	Condensing Economizer[90,91]
Hot Water Boiler	335 °F	247.5 °F
Steam Boiler	375 °F	287.5 °F

[87] Assumes hot water boiler efficiency of 82% and steam boiler efficiency of 80%

[88] As cited in U.S. DOE, Steam Tip Sheet #26A, Consider Installing a Condensing Economizer, the minimum stack temperature for a non-condensing economizer is 250°F. The average temperature drop is assumed to be halfway between the baseline and efficient temperature minimum: (420°F + 250°F) / 2 = 335°F

[89] Ibid, the minimum stack temperature for a non-condensing economizer is 250°F: (500°F + 250°F) / 2 = 375°F

[90] Ibid, the minimum stack temperature for a condensing economizer is 75°F: (420°F + 75°F) / 2 = 247.5°F

[91] Ibid, the minimum stack temperature for a condensing economizer is 75°F: (500°F + 75°F) / 2 = 287.5°F

Peak Factors

Table 3-126 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) of the boiler economizer is limited to the remaining useful life (RUL) of the boiler. If unknown, assume 1/3 of the boiler EUL.

Table 3-127 Measure Life

Equipment	EUL	RUL	Ref
Boiler	20	6.67	[482]

References

[483] US DOE, "Improving Steam System Performance: A Sourcebook for Industry, Second Edition", 2004. https://www.energy.gov/sites/prod/files/2014/05/f15/steamsourcebook.pdf

[484] US DOE, "ADVANCED MANUFACTURING OFFICE Energy Tips: STEAM Steam Tip Sheet #26A." n.d. https://www.energy.gov/sites/prod/files/2014/05/f16/steam26a_condensing.pdf

[485] US DOE, "ADVANCED MANUFACTURING OFFICE Energy Tips: STEAM Steam Tip Sheet #26B." n.d. https://www.energy.gov/sites/prod/files/2014/05/f16/steam26b_condensing.pdf

[486] US DOE, "ADVANCED MANUFACTURING PROGRAM Energy Tips: STEAM Steam Tip Sheet #3 Use Feedwater Economizers for Waste Heat Recovery." n.d. https://www.energy.gov/sites/prod/files/2014/05/f16/steam3_recovery.pdf

[487] ECCCNYS 2020 Table C403.3.2(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers & Table C404.2: Minimum Performance of Water Heating Equipment. https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-ce-commercial-energy-efficiency

[488] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[489] California Database of Energy Efficient Resources (DEER). http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

[490] *2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0: Volume 2* (2022), Pg 357. https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf

3.5.7 GAS CHILLERS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC
Baseline	Code
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure describes the energy savings resulting from installing a gas-fueled absorption chiller more efficient than code. The calculation of energy savings for C&I gas fired chillers and in time of sale and new construction applications is based on algorithms with key variables captured on the application form or from manufacturer's data sheets.

Note that this measure applies to only absorption chillers, in keeping with ASHRAE 90.1-2019 efficiency specifications. For other types of gas chillers, or complex cooling systems, consider using a custom analysis approach.

Baseline Case

Minimally code-compliant gas-fueled absorption chiller with a baseline efficiency as defined in ASHRAE 90.1-2019.

Efficient Case

A new efficient gas-fueled absorption chiller, more efficient than code.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = Cap \times (\frac{1}{COP_b} - \frac{1}{COP_q}) \times EFLH_c \times 10$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = N/A$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-128 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{winter}$	Annual winter fuel savings	Calculated	Therms/yr	
$Therms_{summer}$	Annual summer fuel usage	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
IR	Input rating	Site-specific	MMBtu/hr	
Cap	Cooling capacity of gas chiller	Site-specific	MMBtu/hr	
COP_b	Coefficient of performance of baseline unit	Site-specific, if unknown look up in Table 3-129	N/A	[492]
COP_q	Coefficient of performance of energy efficient unit	Site-specific	N/A	
$EFLH_h$	Equivalent full load hours, heating	Look up in Appendix C:		
CF	Electric coincidence factor	Look up in Table 3-130	N/A	
PDF	Gas peak day factor	Look up in Table 3-130	N/A	
10	Unit conversion, Therms/MMBtu	10	Therms/MMBtu	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-129 Minimum Gas Chiller Efficiencies, AHRAE 90.1-2019

Equipment	Minimum COP
Air cooled absorption, single effect	0.6 FL
Water cooled absorption, single effect	0.7 FL
Absorption double effect, indirect fired	1.0 FL 1.05 IPLV
Absorption double effect, direct fired	1.0 FL 1.0 IPLV

Peak Factors

Table 3-130 Peak Factors

Peak Factor	Value
Electric coincidence factor (CF)	N/A
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors

Measure Life

The effective useful life (EUL) is 20 years [491].

References

[491] DEER 2014
[492] ASHRAE 90.1 2019 Table 6.8.1-3

3.5.8 ELECTRIC CHILLERS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC
Baseline	Code
End Use Subcategory	Equipment
Measure Last Reviewed	December 2022

Description

This prescriptive measure targets the use of electric chillers in all commercial facilities.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline chiller is a minimally code-compliant chiller with an efficiency as required by ASHRAE Std. 90.1 – 2019, which is the current code adopted by the state of New Jersey.

Baseline Case

New Construction/Replacement of Failed Equipment/End of Useful Life: Chiller compliant with ASHRAE Std. 90.1–2019.

Efficient Case

Chiller with an efficiency greater than code.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = Tons \times EFLH_c \times (IPLV_b - IPLV_q)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = Tons \times CF \times (FLV_b - FLV_q)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-131 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Tons/Unit	Rated capacity of cooling equipment.	Site-specific	Tons	
$IPLV_b$	Integrated Part Load Value of baseline equipment, the efficiency of the chiller under partial-load conditions	Site-specific. If unknown, look up in Table 3-132	kW/ton	[494]
$IPLV_q$	Integrated Part Load Value of qualifying unit, the efficiency of the chiller under partial-load conditions	Site-specific	kW/ton	
FLV_b	Full Load Value of baseline equipment, the efficiency of the chiller under full-load conditions	Site-specific. If unknown, look up in Table 3-132	kW/ton	[494]
FLV_q	Full Load Value of qualifying equipment, the efficiency of the chiller under full-load conditions	Site-specific	kW/ton	
$EFLH_c$	Equivalent Full Load Cooling Hours	Look up in Appendix C: Heating and Cooling EFLH	hr	[495]
CF	Electric coincidence factor	Table 3-133	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-132 Water-Chilling Minimum Efficiency, ASHRAE 90.1–2019 (Table 6.8.1-3)

Equipment Type	Size Category	Path A		Path B	
		FLV (kW/ton)	IPLV (kW/ton)	FLV (kW/ton)	IPLV (kW/ton)
Air Cooled	tons < 150	1.188	0.876	1.237	0.759
	tons > 150	1.188	0.857	1.237	0.745
Water Cooled Positive Displacement (rotary screw and scroll)	tons < 75	0.750	0.600	0.780	0.500
	75 +< tons < 150	0.720	0.560	0.750	0.490
	150 =< tons < 300	0.660	0.540	0.680	0.440
	300 =< tons < 600	0.610	0.520	0.625	0.410
	tons => 600	0.560	0.500	0.585	0.380
Water Cooled Centrifugal	tons < 150	0.610	0.550	0.695	0.440
	150 < tons < 300	0.610	0.550	0.635	0.400
	300 < tons < 400	0.560	0.520	0.595	0.390
	400 < tons < 600	0.560	0.500	0.585	0.380
	tons > 600	0.560	0.500	0.585	0.380

Notes:

1. Path A is generally used with equipment designed to maximize full load efficiency. Either Path A or Path B may be used to demonstrate compliance.
2. Path B is generally used with equipment designed to maximize part-load efficiency. Either Path A or Path B may be used to demonstrate compliance.
3. Typically, constant speed chillers use Path A values whereas variable speed chillers use Path B values.

Peak Factors

Table 3-133 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.67	[493]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 23 years. [496]

References

[493] New Jersey Board of Public Utilities, *New Jersey's Clean Energy Program Protocols to Measure Resource Savings: FY2022 Addendum*. (New Jersey Board of Public Utilities, 2022), pg 27.

[494] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-3. https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[495] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.

[496] GDS Associates, Inc. 2007. *Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for the New England State Program Working Group (SPWG).

3.5.9 MAKE-UP AIR UNIT

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/DI
Baseline	Code/Dual
End Use	HVAC
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for make-up air systems in commercial applications. These systems utilize an indirect gas-fired process to heat 100% outside air (OA) to provide ventilation or make-up air to commercial and industrial spaces. The unitary package must contain an indirect gas-fired warm air furnace section.

The annual OA heating load per cfm of OA (Q_{OA}) was determined for each New Jersey location by scaling the heating load derived from the Illinois TRM V9.0 using heating degree days for each location.

The IL TRM Q_{OA} Values were determined based on hourly differences between a range of supply air temperatures (SAT) and outside air temperature (OAT) using TMY3 Data. 3 different base temperatures were used to calculate the heating loads, 45 °F, 55 °F, and 65 °F. The loads are then summed for the entire year.

To determine the appropriate value, follow the guidance below to use Table 3-135 through Table 3-147.

First, select the most representative operating schedule for the application from among the four scenarios listed below. Second, select the representative HDD base temperature. If that base temperature is not readily determined, select the TRM default base temperature of 55 °F (HDD55) for heating in C&I settings. Third, select the climate zone. Fourth, select an appropriate heated to supply air (SA) temperature. Use the resulting Q_{OA} value.

The four scenarios available are indicative of the following building applications and operating schedules:

1. 24-hour-a-day and 7-day-a-week (24/7) operation, with HVAC operating schedule of 8,760 hours per year, typical of large retail stores with DOAS, hotel/multifamily buildings with corridor MUAS, and healthcare facilities with DOAS. Use Table 3-136 through Table 3-138.
2. 6:00 AM to 1:00 AM every day operation, with HVAC operating schedule of 7,300 hours per year, typical of full service and quick service restaurants with kitchen MUAS. Use Table 3-139 through Table 3-141.
3. 7:00 AM to 9:00 PM Monday-Friday, 7:00 AM to 10:00 PM Saturday, and 9:00 AM to 7:00 PM Sunday operations, with HVAC operating schedule of 5,266 hours per year, typical of non-24/7 retail stores with DOAS. Use Table 3-142 through Table 3-144.
4. 7:00 AM to 9:00 PM Monday-Friday operation, with HVAC operating schedule of 3,911 hours per year, typical of school buildings with DOAS. Use Table 3-145 through Table 3-147.

Baseline Case

The baseline case is a make-up air unit that contains a non-condensing gas-fired warm air furnace compliant with ASHRAE Std. 90.1 – 2019 and IECC 2021.

Efficient Case

The efficient case is an efficient make-up air unit that contains a condensing gas-fired warm air furnace with a thermal efficiency higher than code.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \frac{t_{fan} \times CFM \times \Delta P}{Eff_{fan,motor} \times 8{,}520}$$

Annual Fuel Savings

$$\Delta Therms = \frac{Q_{OA} \times CFM \times \left(\frac{1}{Eff_b} - \frac{1}{Eff_q}\right)}{100{,}000}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{t_{fan}} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-134 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
t_{fan}	Supply air fan runtime	Use one of the 4 scenarios in the description above	Hours	
CFM	Supply fan airflow	Site-specific	ft^3/min	
ΔP	Additional pressure drop of the condensing heat exchanger of warm air furnace section	-0.15	Inch w.g.	[497]
$Eff_{fan,motor}$	Combined fan and motor efficiency	0.6	N/A	[497]
8,520[92]	Conversion factor	8,520	N/A	
Q_{OA}	Annual outside air heating load per cfm of OA	Look up in Table 3-136 through Table 3-147	Btu/cfm	[497]
Eff_b	Baseline non condensing efficiency	Look up in Table 3-135	N/A	[498]
Eff_q	Efficient condensing efficiency	Site-specific. Use the same efficiency metric as Eff_b	N/A	
100,000	Conversion from Btu to therm	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 3-148	N/A	
PDF	Gas peak demand factor	Look up in Table 3-148	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

[92] Fan horsepower (HP) calculation constant of 6,356 for standard air conditions adjusted by 1 HP = 0.746 kW, or (6,356 / 0.746) = 8,520 for this kW calculation.

Table 3-135 Furnace Baseline Efficiencies

Furnace Type	Size Category (kBtu input)	Standard 90.1-2019
Gas Fired	< 225	Nonweatherized 80% AFUE Weatherized 81% AFUE
Gas Fired	≥ 225	81% Et
Oil Fired	< 225	Nonweatherized excluding mobile home 83% AFUE Nonweatherized mobile home 75% AFUE Weatherized 78% AFUE
Oil Fired	≥ 225	82% Et

Table 3-136 8760 Annual Operation Scenario for HDD45

t_{fan} = 8760 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75ºF	85ºF	95ºF	105ºF
Northern	138,650	169,078	199,506	229,934
Southwest	123,809	150,980	178,151	205,322
Coastal	76,756	93,601	110,446	127,291
Central	117,464	143,242	169,021	194,800
Pine Barrens	115,338	140,651	165,962	191,275
Statewide Average	115,016	140,258	165,499	190,741

Table 3-137 8760 Hour Annual Operation Scenario for HDD55

t_{fan} = 8760 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75ºF	85ºF	95ºF	105ºF
Northern	182,976	227,595	272,214	316,833
Southwest	166,370	206,940	247,510	288,079
Coastal	125,238	155,777	186,317	216,856
Central	162,154	201,695	241,236	280,777
Pine Barrens	160,335	199,433	238,531	277,628
Statewide Average	160,051	199,079	238,108	277,136

Table 3-138 8760 Hour Annual Operation Scenario for HDD65

t_{fan} = 8760 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	218,007	280,807	343,606	406,405
Southwest	201,016	258,922	316,827	374,732
Coastal	170,353	219,425	268,498	317,570
Central	198,527	255,715	312,904	370,091
Pine Barrens	196,445	253,034	309,623	366,211
Statewide Average	197,376	254,232	311,089	367,945

Table 3-139 7300 Annual Operation Scenario for HDD45

t_{fan} = 7300 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	111,241	135,739	160,237	184,734
Southwest	99,334	121,210	143,085	164,960
Coastal	61,583	75,145	88,707	102,268
Central	94,243	114,998	135,752	156,506
Pine Barrens	92,538	112,917	133,296	153,674
Statewide Average	92,280	112,602	132,924	153,245

Table 3-140 7300 Annual Operation Scenario for HDD55

t_{fan} = 7300 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	146,885	182,811	218,738	254,664
Southwest	133,554	166,220	198,886	231,552
Coastal	100,535	125,125	149,715	174,305
Central	130,169	162,007	193,845	225,683
Pine Barrens	128,709	160,190	191,671	223,152
Statewide Average	128,481	159,906	191,331	222,756

Table 3-141 7300 Annual Operation Scenario for HDD65

t_{fan} = 7300 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	174,841	225,198	275,554	325,911
Southwest	161,214	207,647	254,079	300,512
Coastal	136,622	175,972	215,321	254,671
Central	159,218	205,075	250,932	296,790
Pine Barrens	157,549	202,925	248,301	293,678
Statewide Average	158,295	203,886	249,477	295,069

Table 3-142 5266 Annual Operation Scenario for HDD45

t_{fan} = 5266 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	76,284	93,254	110,223	127,194
Southwest	68,118	83,272	98,425	113,579
Coastal	42,231	51,625	61,019	70,414
Central	64,627	79,004	93,381	107,758
Pine Barrens	63,458	77,575	91,691	105,808
Statewide Average	63,281	77,358	91,435	105,513

Table 3-143 5266 Annual Operation Scenario for HDD55

t_{fan} = 5266 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	100,163	124,786	149,408	174,031
Southwest	91,073	113,461	135,848	158,237
Coastal	68,557	85,409	102,262	119,115
Central	88,765	110,585	132,405	154,226
Pine Barrens	87,769	109,345	130,920	152,496
Statewide Average	87,614	109,151	130,688	152,226

Table 3-144 5266 Annual Operation Scenario for HDD65

t_{fan} = 5266 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	119,326	153,797	188,268	222,738
Southwest	110,026	141,810	173,595	205,378
Coastal	93,242	120,178	147,114	174,049
Central	108,663	140,054	171,445	202,835
Pine Barrens	107,524	138,586	169,647	200,708
Statewide Average	108,033	139,242	170,451	201,659

Table 3-145 3911 Annual Operation Scenario for HDD45

t_{fan} = 3911 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	54,942	67,170	79,398	91,626
Southwest	49,061	59,980	70,900	81,819
Coastal	30,416	37,185	43,955	50,724
Central	46,546	56,906	67,266	77,625
Pine Barrens	45,704	55,876	66,049	76,221
Statewide Average	45,577	55,720	65,865	76,008

Table 3-146 3911 Annual Operation Scenario for HDD55

t_{fan} = 3911 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	72,525	90,433	108,340	126,247
Southwest	65,943	82,225	98,507	114,789
Coastal	49,640	61,896	74,153	86,410
Central	64,272	80,141	96,011	111,880
Pine Barrens	63,551	79,242	94,934	110,625
Statewide Average	63,438	79,102	94,766	110,429

Table 3-147 3911 Annual Operation Scenario for HDD65

t_{fan} = 3911 Hours	Q_{oa} (Annual Btu/cfm) At Supply Air Temperature Of			
Climate Zone - Weather Station/City	75°F	85°F	95°F	105°F
Northern	87,018	112,390	137,763	163,136
Southwest	80,236	103,631	127,026	150,422
Coastal	67,996	87,823	107,649	127,476
Central	79,242	102,348	125,453	148,559
Pine Barrens	78,411	101,275	124,138	147,001
Statewide Average	78,782	101,754	124,725	147,697

Peak Factors

Table 3-148 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	[497]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-149 Measure Life

Equipment	EUL	RUL	Ref
Make-up Air Unit	15	5	[499]

References

[497] *2022 Illinois Statewide Technical Reference Manual for Energy Efficiency V10: Volume 2 Commercial and Industrial Measures*. (2021), Pg 405-412, https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf.

[498] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-5, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards.

[499] DEER 2014 EUL http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx.

3.5.10 HEAT OR ENERGY RECOVERY VENTILATOR

Market	Commercial/Multifamily
Baseline Condition	NC/RF/TOS
Baseline	Code/Existing
End Use Subcategory	Heat Recovery
Measure Last Reviewed	January 2023

Description

This measure covers the installation of Energy Recovery Ventilators (ERV) and Heat Recovery Ventilators (HRV). ERVs and HRVs reduce heating and cooling loads while maintaining required ventilation rates by facilitating heat transfer between outgoing conditioned air and incoming outdoor air. ERVs and HRVs employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of pre-conditioning outdoor air prior to supplying the conditioned air to the space, either directly or as part of an air-conditioning system. For new construction, this measure only applies in cases where ERV/HRV functionality is not required by federal, state, local or municipal codes or standards. This measure is also applicable to retrofit of existing buildings. For the purposes of this measure, ERVs and HRVs are distinguished as follows:

- Energy Recovery Ventilator (ERV): Transfers both sensible (heat content) and latent (moisture content) heat between supply and exhaust airstreams.
- Heat Recovery Ventilator (HRV): Transfers sensible heat only between supply and exhaust airstreams.

Baseline Case

The baseline condition for this measure is a commercial or multifamily high-rise building with an ASHRAE 62.2-compliant exhaust fan system with no heat or energy recovery.

Efficient Case

The compliance condition for this measure is a commercial or multifamily high-rise building with an ASHRAE 62.2-compliant exhaust fan system equipped with AHRI certified ERV or HRV components.

Annual Energy Savings Algorithms

Note: Conversions from SEER to SEER2, EER to EER2, and HSPF to HSPF2 can be found in Appendix E: Code-Compliant Efficiencies.

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_c + \Delta kWh_h + \Delta kWh_{fan}$$

Cooling energy savings:

For ERVs:

$$\Delta kWh_c = \frac{4.5 \times CFM \times Eff_{hx,total} \times \left(H_{outdoor,c} - H_{indoor,c}\right)}{1{,}000 \times Eff_{elec,c}} \times hrs_c$$

For HRVs:

$$\Delta kWh_c = \frac{1.08 \times CFM \times Eff_{hx,sens} \times \left(T_{outdoor,c} - T_{indoor,c}\right)}{1{,}000 \times Eff_{elec,c}} \times hrs_c$$

Heating energy savings (both ERVs and HRVs):

$$\Delta kWh_h = \frac{1.08 \times CFM \times Eff_{hx,sens} \times \left(T_{indoor,h} - T_{outdoor,h}\right)}{1{,}000 \times HSPF2} \times F_{ElecHeat} \times hrs_h$$

Fan energy savings:

$$\Delta kWh_{fan} = \left(kW_{fan,b} - kW_{fan,q}\right) \times (hrs_h + hrs_c)$$

Calculate baseline and qualifying fan kW as follows.[93] Use first equation if values are known, otherwise use second equation:

$$kW_{fan} = \sum\left(\frac{CFM \times \Delta P}{33{,}013/5.202 \times Eff_{fan,mech} \times Eff_{fan,motor}} \times 0.746\right)$$

$$kW_{fan} = \sum\left(\frac{HP \times LF}{Eff_{fan,motor}} \times 0.746\right)$$

Annual Fuel Savings

$$\Delta Therms = \frac{1.08 \times CFM \times Eff_{hx,sens} \times \left(T_{indoor,h} - T_{oudoor,h}\right)}{100{,}000 \times Eff_{fuel,h}} \times F_{FuelHeat} \times hrs_h$$

Summer Peak Demand Savings

For ERVs:

$$\Delta kW_{Peak} = \left(\frac{4.5 \times CFM \times Eff_{hx,total} \times (H_{outdoor,c,peak} - H_{indoor,c})}{1{,}000 \times EER2} + (kW_{fan,b} - kW_{fan,q})\right) \times CF$$

For HRVs:

$$\Delta kW_{Peak} = \left(\frac{1.08 \times CFM \times Eff_{hx,sense} \times (T_{outdoor,c,peak} - T_{indoor,c})}{1{,}000 \times EER2} + (kW_{fan,b} - kW_{fan,q})\right) \times CF$$

[93] Represents total electric power of ERV/HRV supply and exhaust fans (kW). Sigma operator included to indicate that this term shall include consideration of all ERV/HRV fans.

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-150 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔkWh_c	Annual electric energy savings during cooling season	Calculated	kWh	
ΔkWh_h	Annual electric energy savings during heating season	Calculated	kWh	
ΔkWh_{fan}	Annual electric energy savings due to fan operation	Calculated	kWh	
$kW_{fan,b}$	Total electric power of baseline supply and exhaust fans	Calculated	kW	
$kW_{fan,q}$	Total electric power of efficient supply and exhaust fans	Calculated	kW	
CFM	Volume of supply air	Site-specific	Ft^3/min	
$Eff_{hx,total}$	Total effectiveness of heat exchanger per rating in accordance with AHRI Standard 1060	Site-specific	N/A	[500]
$Eff_{hx,sens}$	Sensible effectiveness of heat exchanger per rating in accordance with AHRI Standard	Site-specific	N/A	[500]

Variable	Description	Value	Units	Ref
$Eff_{elec,c}$	Seasonal average energy efficiency of electric cooling equipment (SEER or IEER)	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size	Btu/watt-hour	[501]
EER2	Energy efficiency ratio of electric cooling equipment[94]	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size	Btu/watt-hour	
HSPF2	Heating seasonal performance factor of electric heating equipment[95]	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size	Btu/watt-hour	
$Eff_{fuel,h}$	Efficiency of fossil fuel heating equipment (AFUE, E_t or E_c)	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size	N/A	
$T_{indoor,h}$	Indoor heating setpoint temperature	Site-specific, if unknown use 70°F	°F	
$T_{indoor,c}$	Indoor cooling setpoint temperature	Site-specific, if unknown use 70°F	°F	
H_{indoor}	Enthalpy of indoor air	Look up in Table 3-151 based on T_{indoor}	Btu/lb	
$Eff_{fan,mech}$	Mechanical efficiency of ERV fans	Site-specific, if unknown use 0.67	N/A	[502]
$Eff_{fan,motor}$	Efficiency of ERV fan motors	Site-specific, if unknown use 0.7[96]	N/A	[503]
ΔP	Pressure drop at nominal airflow in the ERV as rated in accordance with AHRI Standard 1060	Site-specific	Inches of H_2O	
HP	Total fan horsepower	Site-specific	HP	
LF	Load factor	Site-specific, if unknown use 0.92	N/A	[508]
hrs_c	Operating hours in the cooling season	Look up in Table 3-152	hrs	[506]
hrs_h	Operating hours in the heating season	Look up in Table 3-152	hrs	[506]
$H_{outdoor,c}$	Enthalpy of outside air during cooling	**Look up in** Table 3-153	Btu/lb	[507]
$H_{outdoor,h}$	Enthalpy of outside air during heating	**Look up in** Table 3-153	Btu/lb	[507]
$T_{outdoor,c}$	Avg. outdoor temperature during cooling season.	**Look up in** Table 3-153	°F	[507]
$T_{outdoor,h}$	Avg. outdoor temperature during heating season	**Look up in** Table 3-153	°F	[507]

[94] If needed, calculate EER as follows:
$EER = (1.12 \times SEER) - (0.02 \times SEER^2)$
[95] If needed, convert COP to HSPF as follows:
$HSPF = COP \times 3.412$
[96] Based on ¼ hp, 4-pole polyphase motor. 10 CFR 431.446

Variable	Description	Value	Units	Ref
$T_{outdoor,c,peak}$	Peak outdoor temperature during cooling season	Look up in Table 3-154	°F	[509]
$H_{outdoor,c,peak}$	Peak Enthalpy of outdoor air during cooling season	Look up in Table 3-154	°F	[509]
$F_{ElecHeat}$	Electric heating factor, to account for presence of electric heat	Use 1 if electric heat, otherwise use 0	N/A	
$F_{FuelHeat}$	Fuel heating factor, to account for presence of fuel heat	Use 1 if fuel heat, otherwise use 0	N/A	
1.08	Specific heat of air × density of inlet air @ 70°F × 60 min/hr	1.08	BTU/h.°F.CFM	
4.5	Density of inlet air at 70 °F x 60 min/hr	4.5	Lb.min/ft^3.hr	
60	Minutes per hour	60	Min/hr	
1,000	Conversion factor, one kW equals 1,000 Watts	1,000	kW/W	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
0.746	Conversion from horsepower to kW	0.746	kW/HP	
33,013	Conversion factor from horsepower to ft.lb/min	33,013	(ft.lb/min)/ hp	
5.202	Conversion factor from inches of water to pounds per square ft	5.202	lb/ft^2)/ inH_2O	
CF	Electric coincidence factor	Look up in Table 3-155	N/A	
PDF	Gas peak day factor	Look up in Table 3-155	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-151 Indoor Enthalpy

Temperature, T_{indoor} (°F)	Enthalpy, H_{indoor} at 50% Relative Humidity (Btu/lb)
65	22.7
66	23.2
67	23.7
68	24.2
69	24.8
70	25.3
71	25.8
72	26.4

Temperature, T_{indoor} (°F)	Enthalpy, H_{indoor} at 50% Relative Humidity (Btu/lb)
73	27.0
74	27.5
75	28.1
76	28.7
77	29.3
78	29.9

Table 3-152 Heating and Cooling Hours[97]

NJ Climate Region	Heating Hours, hrs_h	Cooling Hours, hrs_c
Northern	4,970	1,670
Southwest	4,896	1,783
Coastal	4,981	1,954
Central	4,969	1,810
Pine Zones	4,899	1,828
Statewide Average	4,953	1,820

Table 3-153 Outdoor Air Temperature and Enthalpy[98]

NJ Climate Region	Relative Humidity[99] (%)	Avg. outdoor temperature[100] during cooling season, $T_{outdoor,c}$ (°F)	Avg. outdoor temperature[100] during heating season, $T_{outdoor,h}$ (°F)	Avg enthalpy[101] of outdoor air at duing cooling season, $H_{outdoor,c}$ (Btu/lb)	Avg enthalpy[101] of outdoor air at duing cooling season, $H_{outdoor,c}$ (Btu/lb)
Northern	69.77	74.60	42.10	32.05	14.39
Southwest	67.39	74.50	42.70	31.51	14.49

[97] Calculated from TMY3 data for representative weather stations for each NJ climate zone. Cooling hours are defined as any hour when outdoor air temperature is above 65°F for the months of June through August and heating hours are defined as any hour when outdoor air temperature is below 65°F for the months of October through April. The heating and cooling hours above represent the count of each in a typical meteorological year. Note: these values may over-estimate hours for buildings with limited operating hours such as offices, schools, etc. Site-specific estimate should be used when possible.

[99] Average of NOAA hourly relative humidity from January 2020 – December 2022 for each climate zone representative weather station (Northern = Allentown, PA; Southern = Philadelphia, PA; Coastal = Atlantic City, NJ; Central = Trenton, NJ; Pine Barrens = McGruire Air Force Base, NJ)

[100] Calculated from TMY3 data for representative weather stations for each NJ climate zone. Cooling hours are defined as any hour when outdoor air temperature is above 65°F for the months of June through August and heating hours are defined as any hour when outdoor air temperature is below 65°F for the months of October through April. The average heating and cooling temperatures are the average temperature of these hours for the typical meteorological year.

[101] Calculated via ASHRAE Dayton's online psychometric tool, using the average NJ elevation of 228 ft above sea level. https://daytonashrae.org/psychrometrics/psychrometrics_imp.html#start

NJ Climate Region	Relative Humidity[99] (%)	Avg. outdoor temperature[100] during cooling season, $T_{outdoor,c}$ (°F)	Avg. outdoor temperature[100] during heating season, $T_{outdoor,h}$ (°F)	Avg enthalpy[101] of outdoor air at duing cooling season, $H_{outdoor,c}$ (Btu/lb)	Avg enthalpy[101] of outdoor air at duing cooling season, $H_{outdoor,c}$ (Btu/lb)
Coastal	74.63	73.00	46.20	31.87	16.47
Central	75.77	74.30	43.20	33.09	15.23
Pine Barrens	74.34	73.70	43.40	32.33	15.22
Statewide Average	72.61	73.91	43.82	32.14	15.31

Table 3-154 Peak Outdoor Air Temperature and Enthalpy

NJ Climate Region	Peak outdoor temperature during cooling season, $T_{outdoor,c,peak}$ (°F)	Peak Enthalpy of outdoor air at duing cooling season, $H_{outdoor,c,peak}$ (Btu/lb)
Northern	89	40.24
Southwest	93	42.28
Coastal	90	41.26
Central	93	42.28
Pine Barrens	94	41.22
Statewide Average	91	41.32

Peak Factors

Table 3-155 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[504]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 14 years[505].

References

[500] *Performance Rating of air-to-air exchanges for Energy Recovery Ventilation Equipment*, (AHRI, 2018). https://www.ahrinet.org/sites/default/files/2022-06/AHRI_Standard_1061_SI_2018.pdf

[501] 10 CFR 430.32 (c)(1) , December 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[502] ASHRAE 90.1 2013, Section 6.5.3.1.3, June 2014. http://arkanarzesh.com/wp-content/uploads/2016/09/ASHRAE%2090.1-2013%20%20-IP.pdf

[503] 10 CFR 431.446 , December 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431

[504] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, and supported by research conducted by Cadmus on behalf of the RM Management Committee, September 2011.

[505] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report, August 2009 https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

[506] ONJSC: Monthly/Annual Temperature Normals (1991-2020), December 2022 http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html.

[507] NSRDB, TMY3 data, December 2022. https://nsrdb.nrel.gov/data-sets/tmy

[508] *Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors*, Cascade Energy, November 5, 2012. Table 6: Load Factor by Nameplate hp and End Use. November 5, 2012

[509] ASHRAE Fundamentals 2021 - Chapter 14 Climactic Design Conditions - https://handbook.ashrae.org/Handbook.aspx#

3.5.11 DEMAND CONTROLLED VENTILATION

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

Maintaining acceptable air quality requires standard ventilation systems designers to determine ventilation rates based on maximum estimated occupancy levels and published CFM/occupant requirements. During low occupancy periods, this approach results in higher ventilation rates than are required to maintain acceptable levels of air quality. This excess ventilation air must be conditioned and therefore results in wasted energy.

Building occupants exhale CO_2, and the CO_2 concentration in the air increases in proportion to the number of occupants. The CO_2 concentration provides a good indicator of overall air quality. Demand control ventilation (DCV) systems monitor indoor air CO_2 concentrations and use this data to automatically modulate dampers and regulate the amount of outdoor air that is supplied for ventilation. DCV is most suited for facilities where occupancy levels are known to fluctuate considerably.

Saving factors were calculated based on IL TRM values for Chicago, adjusted by ratio of Degree Days for each listed NJ Climate Zone and Chicago, based on TMY 3 Data using base 65 F balance point. See the 'Demand Controlled Ventilation' Section of the Illinois Statewide Technical Reference Manual V11 for further explanation [510].

Baseline Case

The baseline system is an existing cooling and heating systems with no demand control ventilation or ventilation heat recovery equipment installed.

Efficient Case

The compliance condition is a DCV system added to the return air system to supply air based on occupancy demands.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{A}{1,000} \times SF_{ElecCool} + \frac{A}{1,000} \times SF_{ElecHeat} \times F_{ElecHeat}$$

Annual Fuel Savings

$$\Delta Therms = \frac{A}{1,000} \times SF_{fuel} \times F_{FuelHeat}$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-156 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
A	Total area square footage of the conditioned space impacted by the measure	Site-specific	Ft^2	
$SF_{ElecCool}$	DCV energy savings factor for cooling	Look up in Table 3-157	kWh/1,000 ft^2	[510]
$SF_{ElecHeat}$	DCV energy savings factor for electric heating	Look up in Table 3-158, Table 3-159	kWh/1,000 ft^2	[510]

Variable	Description	Value	Units	Ref
$F_{elecHeat}$	Electric heating factor, used to account for the presence or absence of an electric heating system	1 (if electric heat) 0 (otherwise)	N/A	
SF_{Fuel}	DCV fuel savings factor for heating	Look up in Table 3-160	Therms/1,000 ft^2	[510]
$F_{FuelHeat}$	Fuel heating factor, used to account for the presence or absence of a fossil fuel heating system	1 (if fossil fuel heat) 0 (otherwise)	N/A	
CF	Electric coincidence factor	Look up in Table 3-161	N/A	
PDF	Gas peak day factor	Look up in Table 3-161	N/A	
10	Unit conversion, Therm/MMBtu	10	Therm/MMBtu	
EUL	Effective useful life	See Measure Life Section	Years	[511]
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-157 Energy Savings Factor for Cooling (kWh/1,000 ft^2)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average[102]
Office - Low-rise (1 to 3 Stories)	267	362	368	366	359	334
Office - Mid-rise (4 to 11 Stories)	211	286	291	289	283	264
Office - High-rise (12+ Stories)	250	340	345	344	337	314
Religious Building	720	978	994	989	970	903
Restaurant	471	640	650	647	634	590
Retail - Department Store	363	493	501	498	489	455
Retail - Strip Mall	251	341	347	345	338	315
Convenience Store	330	448	455	453	444	413
Elementary School	339	460	468	465	456	425
High School	332	450	457	455	446	415
College/ University	393	534	543	540	530	493
Healthcare Clinic	327	444	451	449	440	410
Lodging (Hotel/Motel)	378	513	521	518	508	473

[102] Weighted average based on NJ climate zone distribution.

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average[102]
Manufacturing	163	222	226	224	220	205
Special Assembly Auditorium	537	729	740	737	722	672
Other	356	483	491	488	479	446
Enclosed Parking Garage	854	1,160	1,179	1,173	1,150	1070

Table 3-158 Electric Heating Savings with Heat Pump (kWh/1,000 ft^2)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average[102]
Office - Low-rise (1 to 3 Stories)	185	149	163	158	163	167
Office - Mid-rise (4 to 11 Stories)	125	100	110	106	109	112
Office - High-rise (12+ Stories)	167	135	147	143	147	151
Religious Building	1,206	970	1,062	1,028	1,057	1,087
Restaurant	870	700	767	742	763	785
Retail - Department Store	298	239	262	254	261	268
Retail - Strip Mall	194	156	171	166	171	175
Convenience Store	147	119	130	126	129	133
Elementary School	517	416	456	441	454	467
High School	505	406	445	430	443	455
College/ University	1007	811	888	859	884	909
Healthcare Clinic	358	288	316	305	314	323
Lodging (Hotel/Motel)	166	134	147	142	146	150
Manufacturing	103	83	91	88	90	93
Special Assembly Auditorium	1,414	1,138	1,246	1,207	1,241	1,276
Other	484	389	426	413	424	436
Enclosed Parking Garage	185	149	163	158	163	167

Table 3-159 Electric Heating Savings with Electrical Resistance (kWh/1,000 ft^2)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Low-rise (1 to 3 Stories)	556	448	490	474	488	493

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Mid-rise (4 to 11 Stories)	374	301	329	319	328	331
Office - High-rise (12+ Stories)	501	403	441	427	439	443
Religious Building	3617	2910	3186	3085	3172	3202
Restaurant	2610	2100	2300	2226	2289	2311
Retail - Department Store	893	718	786	761	783	790
Retail - Strip Mall	584	470	515	498	512	517
Convenience Store	441	355	389	376	387	391
Elementary School	1551	1248	1367	1323	1360	1374
High School	1513	1218	1333	1291	1327	1340
College/ University	3022	2432	2662	2577	2650	2676
Healthcare Clinic	1074	865	947	916	942	952
Lodging (Hotel/Motel)	498	401	439	425	437	441
Manufacturing	310	250	273	265	272	275
Special Assembly Auditorium	4242	3414	3738	3619	3721	3757
Other	1452	1169	1280	1239	1274	1286

Table 3-160 Fuel Heating Savings (therms/1000 SF)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Low-rise (1 to 3 Stories)	24	19	21	20	21	21
Office - Mid-rise (4 to 11 Stories)	16	13	14	14	14	14
Office - High-rise (12+ Stories)	22	17	19	19	19	19
Religious Building	155	124	136	132	136	137
Restaurant	111	90	98	95	98	99
Retail - Department Store	38	31	33	32	33	33
Retail - Strip Mall	25	20	22	22	22	22
Convenience Store	19	15	17	16	17	17
Elementary School	66	53	58	56	58	58
High School	64	52	57	55	56	57
College/ University	129	104	114	110	113	114

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Healthcare Clinic	46	37	41	39	40	41
Lodging (Hotel/Motel)	21	17	18	18	18	18
Manufacturing	14	11	12	12	12	12
Special Assembly Auditorium	181	146	159	154	159	160
Other	61	49	54	52	54	54

Peak Factors

Table 3-161 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Use the smaller of the measure life (10 yr) or the remaining useful life (RUL) of host equipment [511]. If applied to a packaged HVAC system, the RUL of the host equipment is 5 years.

References

[510] *2023 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 11 Volume 2: Commerical and Industrial Measures* (September 2022), Pg 357, https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010123_v11.0_Vol_2_C_and_I_092222_FINAL.pdf

[511] ERS (2005). *Measure Life Study prepared for The Massachusetts Joint Utilities*.

3.5.12 DEMAND CONTROLLED KITCHEN VENTILATION

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

Installation of variable speed drives (VSD) on commercial kitchen exhaust fans and make-up air fans allows the variation of ventilation based on cooking load and/or time of day. This measure is targeted to non-residential customers whose kitchen exhaust fans and make-up air fans are equipped with a VSD that varies the exhaust rate of kitchen ventilation based on the energy and effluent output from the cooking appliances (i.e., the more heat and smoke/vapors generated, the more ventilation needed). This involves installing a temperature sensor in the hood exhaust collar and/or an optic sensor on the end of the hood that sense cooking conditions which allows the system to automatically vary the rate of exhaust to what is needed by adjusting the fan speed.

Baseline Case

The baseline equipment is a constant speed commercial kitchen ventilation system.

Efficient Case

The energy efficient condition is a commercial kitchen ventilation system equipped with a VSD and demand ventilation controls and sensors.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{fan} + \Delta kWh_{cooling}$$

$$\Delta kWh_{fan} = \left(\frac{CFM}{1400}\right) \times Hours \times Days \times Weeks \times \sum_{0\%}^{100\%} \%FF \times PLR$$

$$\Delta kWh_{cooling} = SF_{cool} \times \%MUA_{cool} \times \Delta kWh_{fan}$$

Annual Fuel Savings

$$\Delta Therms = SF_{heat} \times \Delta kWh_{fan} \times 10$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{\Delta kWh}{Hours \times Days \times Weeks}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-162 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
CFM	Uncontrolled design hood exhaust flow in cubic feet per minute.	Site-specific If actual flow is unknown, estimate flow from hood dimensions. For unlisted hoods estimate 100 CFM per square foot of plan area. For UL listed hoods estimate 250 CFM per length of hood in feet.	cfm	[515]
1,400	Estimation of CFM delivered per kW consumed from both exhaust and make-up air fan motor	1,400	Cfm/kW	[513]
Hours	Hours per day hood is operated	Site-specific, if actual hours are unknown assume 5 hours per meal served.	hrs	[515]
Days	Number of days kitchen is in operation per week	Site-specific	Days	

Variable	Description	Value	Units	Ref
Weeks	Number of weeks kitchen is in operation	Site-specific, if actual weeks are unknown assume 50 weeks per year.	Weeks	[515]
%FF	Percentage of run-time spent within a given flow fraction range	Site-specific, if actual values unknown assume 30% of time at full flow, 30% of time at 75% flow, and 40% of time at 50% flow	N/A	[515]
PLR	Part load ratio for a given flow fraction range	Look up Table 3-163	N/A	[515]
SF_{cool}	Cooling savings factor	0.471	N/A	[514]
$\%MUA_{cool}$	During the cooling season, the percentage of make-up air that is conditioned	If kitchen is cooled, then %MUA = 1.0. If kitchen is not cooled, then must calculate the percentage of make-up air that is being pulled from the dining room or other conditioned space. = If actual value is unknown, then assume 30%, or 0.3.	N/A	[515]
SF_{heat}	Heating savings factor	Lookup Table 3-164. If percent of make-up air from dining room is unknown, assume 30% from dining room	MMBtu/kWh	[514] [515]
CF	Electric coincidence factor	Look up in Table 3-165	N/A	
PDF	Gas peak day factor	Look up in Table 3-165	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-163 Part Load Ratios by Control and Fan Type and Flow Fraction (PLR)

Control Type	Flow Fraction									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
VFD	0.09	0.10	0.11	0.15	0.20	0.28	0.41	0.57	0.77	1.00

Table 3-164 Heating Savings Factor (SF_{Heat})

Percent of Make-up Air from Nearby Conditioned Space (Dining Room)	Make-up Air Directly Supplied to Kitchen is NOT Heated	Make-up Air Directly Supplied to Kitchen is Heated
0%	0	0.0088
10%	0.0013	0.0093
20%	0.0026	0.0097
30%	0.0039	0.0101
40%	0.0042	0.0105

Percent of Make-up Air from Nearby Conditioned Space (Dining Room)	Make-up Air Directly Supplied to Kitchen is NOT Heated	Make-up Air Directly Supplied to Kitchen is Heated
50%	0.0065	0.0109
60%	0.0078	0.0113
70%	0.0091	0.0118
80%	0.0104	0.0122
90%	0.0117	0.0126
100%	0.0130	0.0130

Peak Factors

Table 3-165 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0 if kitchen operates during dinner 0.0 if the kitchen does not operate during dinner	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 15 years. [512]

References

[512] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

[513] Estimation of CFM delivered per kW consumed from both exhaust and make-up air fan motor. Derived from proprietary Navigant DCKW tool.

[514] Savings factor calculated from proprietary Navigant DCKW tool using TMY3 temperature data from Baltimore, MD. The tool does a bin hour calculation of the cooling energy required to condition make-up air.

[515] *Mid-Atlantic Technical Reference Manual: Version 10* (May 2020), https://neep.org/mid-atlantic-technical-reference-manual-trm-v10, Pg 404

4.3.1 DESTRATIFICATION FAN

Market	Commercial
Baseline Condition	NC/RF
Baseline	ISP/Existing
End Use Subcategory	HVAC
Measure Last Reviewed	May 2023

Description

This measure applies to buildings with high bay ceiling construction without fans currently installed for the purpose of destratifying air. Air stratification leads to higher temperatures at the ceiling and lower temperatures at the ground. During the heating season, destratification fans improve air temperature distribution in a space by circulating warmer air from the ceiling back down to the floor level, thereby enhancing comfort and saving energy. Energy savings are realized by a reduction of heat loss through the roof-deck and walls as a result of a smaller temperature differential between indoor temperature and outdoor air. This measure does not attempt to quantify savings from shorter heating system runtimes due to air mixing.

Limitations

- For use in conditioned, high bay structures. Recommended minimum ceiling height of 20 ft.
- This measure should only be applied to spaces in which the ceiling is subject to heat loss to outdoor air (i.e., single story or top floor spaces) and where there is sufficient space to allow for appropriate spacing of the fans. Other applications require custom analysis.
- Installation must follow manufacturer recommendations sufficient to effectively destratify the entire space.
- Measure does not currently support facilities with night setbacks on heating equipment. Custom analysis is needed in this case.
- Certain heating systems may not be a good fit for destratification fans, such as locations with: high velocity vertical throw unit heaters, radiant heaters, and centralized forced air systems. In these cases, measured evidence of stratification should be confirmed, and custom analysis may be necessary.

Baseline Case

No destratification fans or other means to effectively mix indoor air.

Efficient Case

High Volume, Low Speed (HVLS) fans with a minimum diameter of 14 ft with Variable Speed Drive (VSD) installed.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_h - kWh_{fan}$$

In all cases:

$$kWh_{fan} = W_{fan} \times hrs_{eff}$$

If building is electricially heated:

$$\Delta kWh_h = \frac{(\Delta Q_r + \Delta Q_w) \times t_{eff} \times 29.31}{100{,}000 \times COP}$$

Where,

$$\Delta Q_r = \frac{1}{R_r} \times A_r \times \left(T_{r,s} - T_{r,d}\right)$$

$$\Delta Q_w = \frac{1}{R_w} \times A_w \times (T_{w,s} - T_{w,d})$$

$$T_{r,s} = m_s \times h_r + (T_{stat} - m_s \times h_{stat})$$

$$T_{r,d} = T_{stat} + 1$$

$$T_{w,s} = m_s \times \frac{h_r}{2} + (T_{stat} - m_s \times h_{stat})$$

$$T_{w,d} = T_{stat} + 0.5$$

If building is not electricially heated:

$$\Delta kWh_h = 0$$

Annual Fuel Savings

$$\Delta Therms = \frac{(\Delta Q_r + \Delta Q_w) \times t_{eff}}{100{,}000 \times Eff}$$

Annual Peak Demand Savings

$$\Delta kWh_{peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-166 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔkWh_h	Savings due to reduced heat loss from air destratification (if building is electrically heated)	Calculated	kWh	
kWh_{fan}	Annual electric consumption of fan	Calculated	kWh	
ΔQ_r	Heat loss reduction through the roof due to the destratification fan	Calculated	Btu/hr	
ΔQ_w	Heat loss reduction through the exterior walls due to destratification fan	Calculated	Btu/hr	
$T_{w,s}$	Average indoor air temperature for wall heat loss, stratified case	Calculated	°F	[516]
$T_{w,d}$	Average indoor air temperature for wall heat loss, destratified case	Calculated	°F	[516]
$T_{r,s}$	Indoor temperature at roof deck, stratified case	Site-specific or calculated	°F	[516]
$T_{r,d}$	Indoor temperature at roof deck, destratified case	Site-specific or calculated	°F	[516]
COP	Heating efficiency of electric heating system	Site-specific, calculate if needed: COP = HSPF/3.413	N/A	[516]
Eff	Fuel heating system efficiency	Site-specific	N/A	[516]

Variable	Description	Value	Units	Ref
R_r	Overall thermal resistance through the roof	**Site-specific, if unknown look up in** Table 3-167	Hr*ft2*F/Btu	[516]
A_r	Roof area	Site-specific	Ft2	[516]
R_w	Overall thermal resistance through the exterior walls	**Site-specific, if unknown look up in** Table 3-167	Hr*ft2*F/Btu	[516]
A_w	Area of exterior walls	Site-specific	Ft^2	[516]
h_r	Ceiling height/roof deck	Site-specific	ft	[516]
T_{stat}	Temperature set point at the thermostat	Site-specific	°F	[516]
h_{stat}	Vertical distance between the floor and the thermostat	Site-specific, if unknown use 5	Ft	[516]
m_s	Estimated heat gain per foot elevation, stratified case	0.8	F/ft	[516]
$EFLH_h$	Effective full load hours, heating	Look up in Appendix C: Heating and Cooling EFLH	Hours	[516]
29.31	Conversion factor	29.31	kWh/therm	[516]
100,000	Conversion factor	100,000	Btu/therm	[516]
PDF	Peak day factor	Look up in Table 3-133	N/A	
EUL	Effective useful life	See Measure Life section	Years	[516]

Table 3-167 Thermal Resistance Factors

Location	Retrofit	New Construction
Roof (Rr)	15.0	30.0
Wall (Rw)	6.5	13.0

Peak Factors

Table 3-168 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A: No peak demand savings because no savings from cooling	[516]
Natural gas peak day factor (PDF)	Look up in Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 10 years [516].

References

[516] Illinois TRM v11, Destratification Fan, pg. 424. https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010123_v11.0_Vol_2_C_and_I_092222_FINAL.pdf

3.5.13 DUCT SEALING AND DUCT INSULATION

Market	**Commercial**
Baseline Condition	RF/DI
Baseline	Existing
End Use Category	HVAC
Measure Last Reviewed	January 2023

Description

This measure describes evaluating the savings associated with performing duct sealing using mastic sealant, metal tape or aerosol sealant to the distribution systems of small commercial buildings with duct systems in unconditioned and semi-conditioned spaces. The application of the measure is limited to residential sized systems less than 65,000 Btu/hr of cooling capacity applied to small commercial buildings. Savings calculations are based on test in / test out duct leakage measurements.

Baseline Case

The baseline condition is existing leaky duct work within an unconditioned or semi-conditioned space in the building.

Efficient Case

The efficient condition is sealed duct work within an unconditioned or semi-conditioned space in the building.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

Where,

$$\Delta kWh_{cooling} = \frac{CFM_{25B} - CFM_{25Q}}{400 \times Cap_{cool}} \times Cap_{cool} \times EFLH_{cool} \times TRF_{cool} \frac{12}{DE_{pre} \times SEER}$$

$$\Delta kWh_{heating} = \frac{CFM_{25B} - CFM_{25Q}}{17 \times Cap_{heat}} \times Cap_{heat} \times EFLH_{heat} \times TRF_{heat} \times \frac{1}{DE_{pre} \times HSPF}$$

Annual Fuel Savings

$$\Delta Therms = \frac{CFM_{25B} - CFM_{25Q}}{17 \times Cap_{heat}} \times Cap_{heat} \times EFLH_{heat} \times TRF_{heat} \times \frac{1}{DE_{pre} \times AFUE\ x\ 100}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh_{cooling}}{EFLH_{cool}} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-169 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{cooling}$	Annual electric energy savings, cooling	Calculated	kWh/yr	
$\Delta kWh_{heating}$	Annual electric energy savings, heating	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
Cap_{cool}	Capacity of air cooling system	Site-specific	ton	
Cap_{heat}	Output capacity of air heating system	Site-specific	kBtu/hr	
CFM_{25B}	Standard duct leakage test result at 25 Pascal pressure differential of the duct system prior to sealing	Site-specific	CFM	
CFM_{25Q}	Standard duct leakage test result at 25 Pascal pressure differential of the duct system after sealing	Site-specific	CFM	
SEER	Seasonal energy efficiency ratio	Site-specific, if unknown look up in Table 2-85	Btu/W·hr	[112]

Variable	Description	Value	Units	Ref
HSPF	Heating seasonal performance factor	Site-specific, if unknown look up in Table 2-85	Btu/W·hr	[112]
DE_{pre}	Distribution efficiency before duct sealing and insulation	0.89	N/A	[519]
AFUE	Annual fuel utilization efficiency	Look up in Table **2-86**xx	N/A	[112]
$EFLH_{cool}$	Cooling equivalent full load hours	See Appendix C	Hrs	
$EFLH_{heat}$	Heating equivalent full load hours	See Appendix C	Hrs	
400	Rule of Thumb, CFM/ton	Site-specific, if unknown use 400	CFM/ton	
TRF_{cool}	Cooling thermal regain factor based on duct location	Semi-conditioned space: 0.0 Unconditioned space or outdoors: 1.0	N/A	[519]
TRF_{heat}	Heating thermal regain factor based on duct location	Semi-conditioned space: 0.4 Unconditioned space or outdoors: 1.0	N/A	[519]
12	Unit conversion, kBtu/hr·ton	12	kBtu/ hr·ton	
100	Unit conversion, kBtu/therm	100	kBtu/therm	
CF	Electric coincidence factor	Look up in Table 2-87	N/A	
PDF	Gas peak day factor	Look up in Table 2-87	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-170 SEER and HSPF Values

Product Class	SEER	HSPF
Split systems – air conditioners	13	-
Split systems – heat pumps	14	8.2
Single package units – air conditioners	14	-
Single package units – heat pumps	14	8.0

Table 3-171 AFUE Values

Product Class	AFUE
Non-weatherized gas furnaces	0.80
Weatherized gas furnaces	0.81

Peak Factors

Table 3-172 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.69	[519]
Natural gas peak day factor (PDF)	See Appendix H: Net-to-Gross Factors	

Measure Life

Table 3-173 Measure Life

Equipment	EUL	Ref
Duct Sealing	15	[116]

References

[517] 10 CFR Subpart C of Part 430, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[518] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[519] Home Energy Services Impact Evaluation, prepared for the Massachusetts Residential Retrofit and Low Income Program Area Evaluation, Cadmus Group, Inc., August 2012.

3.5.14 EC MOTORS

Market	Commercial/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Motor
Measure Last Reviewed	December 2022

Description

This measure covers the retrofit installation of an Electronically Commuted (EC) motor to replace an existing HVAC supply fan motor or hydronic circulator pump motor.

This measure is not applicable to exhaust fan motors. New construction and replace-on-burnout scenarios are not eligible because ECM technology is required in new equipment by federal efficiency standards [520].

Interactive factors should be applied for motors that supply cooling or heating to account for the reduced cooling load, or increased heating load, associated with the lower wattage ECM motor. Interactive factors do not apply if the motor is located outside of the conditioned air or hydronic pathway.

Baseline Case

An existing HVAC fan or pump with a single-speed, shaded-pole (SP) or permanent-split capacitor (PSC) motor. Baseline wattage should be derived from the nameplate rating of the existing motor.

Efficient Case

HVAC fan or pump with an Electronically Commuted (EC) Motor

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_h + \Delta kWh_c$$

For blower fans:

$$\Delta kWh_h = \frac{(W_b \times ESF_h)}{1{,}000} \times LF \times Hrs_h \times (1 - HVAC_e)$$

$$\Delta kWh_c = \frac{(W_b \times ESF_c)}{1{,}000} \times LF \times Hrs_c \times (1 + HVAC_e)$$

For circulator pumps:

$$\Delta kWh_h = \frac{(W_b - W_q)}{1{,}000} \times Hrs_h \times (1 - HVAC_e)$$

$$\Delta kWh_c = \frac{(W_b - W_q)}{1{,}000} \times Hrs_c \times (1 + HVAC_e)$$

If motor wattage is unknown, estimate as:

$$W = \frac{0.746 \times HP}{Eff_{motor}}$$

Annual Fuel Savings

$$\Delta Therms = \frac{W_b \times ESF_h}{1{,}000} \times LF \times Hrs_h \times HVAC_{ff}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{(W_b \times ESF_c)}{1{,}000} \times LF \times (1 + HVAC_d) \times CF$$

Peak Daily Fuel Savings:

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-174 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_h	Annual electric heating savings	Calculated	kWh/yr	
ΔkWh_c	Annual electric cooling savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
W_b	Wattage of baseline motor	Site-specific, if unknown calculate from HP	Watts	
W_q	Wattage of efficient motor	Site-specific	Watts	

Variable	Description	Value	Units	Ref
Eff_{motor}	Motor efficiency	Site-specific, if unknown look up in Table 3-175	N/A	[523]
Hrs_h	Motor operating hours, heating	Site-specific, if unknown see Appendix D: HVAC Fan and Pump Operating Hours	Hrs	
Hrs_c	Motor operating hours, cooling	Site-specific, if unknown see Appendix D: HVAC Fan and Pump Operating Hours	Hrs	
ESF_h	Energy savings factor, heating	0.23	N/A	[522]
ESF_c	Energy savings factor, cooling	0.38		[522]
LF	Motor load factor	0.9	N/A	[522]
$HVAC_e$	HVAC interactivity factor, electric	See Appendix F: HVAC Interactivity Factors	N/A	
$HVAC_d$	HVAC interactivity factor, demand	See Appendix F: HVAC Interactivity Factors	N/A	
$HVAC_{ff}$	HVAC interactivity factor, fossil fuel	See Appendix F: HVAC Interactivity Factors	N/A	
CF	Coincidence factor	Look up in Table 3-176	N/A	
PDF	Gas peak demand factor	Look up in Table 3-176	N/A	
0.746	Conversion factor	0.746	kWh/HP	
1,000	Conversion factor	1,000	Watts/kW	
100	Conversion factor	100	kBtu/Therms	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-175 Default Motor Efficiency by Motor Type

Motor Type	Assumed Efficiency
Shaded Pole (SP)	0.40
Permanent Split Capacitor (PSC)	0.50
ECM	0.70

Peak Factors

Table 3-176 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[521]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for retrofit projects is assumed to equal to the smaller or the motor EUL or the RUL of the host equipment. Default RUL of the host equipment is 1/3 of the EUL.

References

[520] Federal standards: U.S. Department of Energy, *Federal Register. 164th ed. Vol. 79*, July 3, 2014. https://www.govinfo.gov/content/pkg/FR-2014-07-03/pdf/FR-2014-07-03.pdf

[521] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential Multifamily, and Commercial/Industrial Measures. Version 6. April 16, 2018.

[522] US DOE, *Evaluation of Retrofit Variable-Speed Furnace Fan Motors*, January 2014. https://www.nrel.gov/docs/fy14osti/60760.pdf

[523] DOE Building Technologies Office. Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment. https://www.energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf. Accessed December 2022.

3.5.15 ECONOMIZER CONTROLS

Market	Commercial/Multifamily
Baseline Condition	NC/RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	December 2022

Description

This measure involves the installation of a dual enthalpy economizer to provide free cooling during the appropriate ambient conditions. Enthalpy refers to the total heat content of the air. A dual enthalpy economizer uses two sensors — one measuring return air enthalpy and one measuring outdoor air enthalpy. Dampers are modulated for optimum and lowest enthalpy to be used for cooling. Retrofit installations are only eligible for savings if the existing HVAC system does not have a functioning economizer.

New construction installations are only eligible for savings when economizers are not already required by the IECC 2021 Energy Code, Section C403.5.

Baseline Case

The baseline condition is the site-specific HVAC unit with fixed outside air (no economizer). If the actual HVAC efficiency is unknown, use the code-compliance efficiency for the unit type, size and age:

- New Construction: Unit compliant with ASHRAE Std. 90.1 – 2019 and IECC 2021.
- Retrofit and DI: Existing unit efficiency. If unknown, use code efficiency based on unit type, size and age.

Efficient Case

The efficiency condition is assumed to be an enthalpy economizer equipped with sensors that monitor the enthalpy of outside air and return air and modulate the outside air damper to optimize energy performance.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = Tons\ x\ \left(\frac{kWh}{ton}\right)_{Econ}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = 0$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-177 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Tons	Rated capacity of the cooling system retrofitted with an economizer	Site specific	Tons	
$(kWh/ton)_{Econ}$	Annual electric energy savings per ton of cooling	Look up in Table 3-178	Hrs/yr	[524]
CF	Electric coincidence factor	Look up in Table 3-179	N/A	
PDF	Gas peak demand factor	Look up in Table 3-179	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-178 Economizer savings kWh per Cooling Ton

Building Type	$(kWh/ton)_{Econ}$
Assembly	27
Big Box Retail	152
Fast Food	39
Full-Service Restaurant	31
Light Industrial	25
Primary School	42
Small Office	186
Small Retail	95
Religious	6
Warehouse	2
TOther	61

Peak Factors

Table 3-179 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-180 Measure Life

Equipment	EUL	RUL	Ref
Economizer Controls	10	3.33	[525]

References

[524] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 10*. (New York State Joint Utilities, 2022), Appendix J Pg 1289-1290 https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

[525] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

3.5.16 GUEST ROOM EMS

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	HVAC controls
Measure Last Reviewed	November 2022

Description

This measure covers the installation of an Energy Management System (EMS) in hotel/motel guest rooms or dormitories which automatically adjust the temperature setback during unoccupied periods. Network controlled systems must also include occupancy sensors in guest rooms. Room occupancy is typically detected by occupancy sensors, infrared sensors or key cards. During unoccupied periods the default setting for controlled units should differ by at least 5 degrees from the operating setpoint. Savings are based on the EMS system's ability to automatically adjust the temperature setpoint of the guest room for various occupancy modes reducing the consumption of electricity and/or gas by requiring less heating and/or cooling when a room or a facility is vacant or unoccupied. Measure applicable to Motel, Hotel and Dormitory building types only.

Baseline Case

Hotel/motel rooms or dormitories with manual heating/cooling temperature set-points and on/off controls.

Efficient Case

Hotel/motel guest room or dormitory with an EMS that automatically adjusts room temperature based on room occupancy during unoccupied periods

Annual Energy Savings Algorithm

Annual Electric Energy Savings

If electric heat:

$$\Delta kWh = \Delta kWh_{cool} + \Delta kWh_{heat}$$

If fuel heat:

$$\Delta kWh = kWh_{cool}$$

Where,

$$\Delta kWh_{cool} = \left(\frac{T_c \times (Hrs_{wk} + 7) + S_c \times (168 - (Hrs_{wk} + 7)}{168} - T_c\right) \times \frac{P_c \times Cap_c \times 12 \times EFLH_c}{EER}$$

$$\Delta kWh_{heat} = \left(T_h - \frac{T_h \times (Hrs_{wk} + 7) + S_h \times (168 - (Hrs_{wk} + 7)}{168}\right) \times \frac{P_h \times Cap_h \times EFLH_h}{COP \times 3{,}412}$$

Annual Fuel Savings

If fuel heat:

$$\Delta Therms = \left(T_h - \frac{T_h \times (Hrs_{wk} + 7) + S_h \times (168 - (Hrs_{wk} + 7)}{168}\right) \times \frac{P_h \times Cap_h \times EFLH_h}{AFUE \times 100{,}000}$$

Peak Demand Savings

$$\Delta kWh_{Peak} = \frac{\Delta kWh_{cool}}{EFLH_c} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \ \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-181 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{cool}	Annual cooling electric energy savings	Calculated	kWh/yr	
ΔkWh_{heat}	Annual heating electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
Cap_h	Heating Capacity	Site-specific	Btu/hr	

Variable	Description	Value	Units	Ref
Cap_c	Cooling capacity	Site-specific	Tons	
T_h	Occupied heating setpoint temperature	Site-specific	°F	
T_c	Occupied cooling setpoint temperature	Site-specific	°F	
COP	Electric heating system coefficient of performance	Site-specific; use 1.0 for electric resistance heat	N/A	
AFUE	Heating Annual Fuel Utilization Efficiency	Site-specific. If unknown, use code compliant efficiency when the equipment was new	N/A	
EER	Cooling Energy Efficiency Ratio	Site-specific. If unknown, use code compliant efficiency when the equipment was new	Btu/hr-W	
Hrs_{wk}	Weekly occupied hours[103]	Site-specific; default to 84	Hr/wk	
S_h	Heating setback temperature	Site-specific; default to T_h - 5	°F	
S_c	Cooling setback temperature	Site-specific; default to T_c + 5	°F	
P_h	Heating savings fraction per degree of setback	0.03	N/A	[526]
P_c	Cooling savings fraction per degree of setback	0.06	N/A	[526]
$EFLH_h$	Heating Equivalent Full Load Hours. Measure applicable to Motel, Hotel and Dormitory building types only.	Look up in Appendix C:	Hr	[527]
$EFLH_c$	Cooling Equivalent Full Load Hours. Measure applicable to Motel, Hotel and Dormitory building types only.	Look up in Appendix C:	Hr	[527]
12	Conversion from tons to kBtu/hr	12	kBtu/h/ton	
168	Hours per week	168	Hr/wk	
7	Weekly hours for setback/setup adjustment based on 1 setback/setup per day, 7 days per week	7	Hr/wk	
3,412	Conversion from Btu to kWh	3,412	Btu/kWh	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
CF	Coincidence factor	Look up in Table 3-182	kW/kWh	
PDF	Peak day factor	Look up in Table 3-182		
EUL	Effective useful life	See Measure Life Section	Years	

[103] Default value assumes operating hours is 12 hours a day, 7 days a week.

Peak Factors

Table 3-182 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.65	[528]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) for add-on equipment is limited to the remaining useful life (RUL) of the underlying system. If unknown, assume 1/3 of the EUL of the base HVAC equipment (look up in relevant HVAC measure).

References

[526] ENERGY STAR Programmable Thermostat Calculator. Savings assumptions per 2004 Industry Data.

[527] Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.

[528] Average of Massachusetts Utilities summer coincidence factors. Massachusetts eTRM, 2020 update, measure code COM-HVAC-HOS. Available online: https://www.masssavedata.com/Public/TechnicalReferenceLibrary

3.5.17 SMART TSTATS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/RF/DI
Baseline	Code/ISP/Existing/Dual
End Use Subcategory	HVAC Control
Measure Last Reviewed	January 2023

Description

The smart thermostat measure involves the replacement of a manually operated or conventional programmable thermostat with a "smart" thermostat (defined below). This measure only applies to thermostats that control central A/C, heat pump, furnace, or rooftop units (RTUs) with capacity up to 300,000 Btu/h that serve normal conditioned spaces, not semi-conditioned spaces or spaces with large, frequently open doors (e.g., loading docks and car repair shops). Thermostats for larger systems should be treated as custom measures. This measure may be a time of sale, retrofit, direct install, or new construction measure.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Retrofit and DI: As a retrofit measure, the baseline equipment is the in-situ manually operated or properly programmed thermostat that was replaced. If a manually operated non-programmable thermostat baseline is claimed, supporting photographic documentation should be collected.

Time of Sale or New Construction: The baseline condition is a programmable thermostat meeting minimum efficiency standards as presented in the 2021 International Energy Conservation Code (IECC 2021).

Efficient Case

The efficient condition is a smart thermostat that has earned ENERGY STAR certification[530] or has followed the ENERGY STAR product requirements[531].

Annual Energy Savings Algorithms

As smart thermostats are control technologies, when possible, heating and cooling savings should be calculated based on data from installed thermostats [532]. Otherwise, cooling savings should only be claimed for buildings with central air conditioning. Heating savings may be claimed for buildings with electric resistance, heat pump, or non-electric heating.

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{\mathrm{c}} + \Delta kWh_{\mathrm{h}}$$

Where,

$$\Delta kWh_c = CCAP \times EFLH_{cool} \times \frac{1}{Eff_{cool}} \times SF_{elec,c}$$

$$\Delta kWh_h = HCAP_{elec} \times EFLH_{heat} \times \frac{1}{HSPF} \times SF_{elec,h}$$

Annual Fuel Savings

$$\Delta Therms = HCAP_{fuel} \times EFLH_{heat} \times \frac{1}{AFUE} \times SF_{fuel}$$

Peak Demand Savings[104]

$$\Delta kW_{Peak} = 0$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

[104] The smart thermostat measure as defined here (i.e., without a corresponding demand reduction program) is assumed to have no demand savings. Smart thermostats with a demand response program added on top may generate demand savings.

Calculation Parameters

Table 3-183 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
CCAP	Cooling capacity of existing AC unit	Site-specific	kBtu/hr	
Eff_{cool}	Cooling efficiency of controlled unit (SEER, SEER2, or IEER). For GSHP, use EER.	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	
$HCAP_{fuel}$	Heating capacity of existing furnace unit	Site-specific	MMBtu/hr	
AFUE	Annual Fuel Utilization Efficiency	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	N/A	
$HCAP_{elec}$	Heating capacity of existing heat pump or electric resistance unit	Site-specific	kBtu/hr	
HSPF	Heating seasonal performance factor of controlled unit	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies. For electric resistance heat, use 3.412	Btu/W-h	
$SF_{elec,c}$	Electrical cooling percent savings from thermostat relative to baseline control	Look up in Table 3-184	%	[534][535]
$SF_{elec,h}$	Electrical heating percent savings from thermostat relative to baseline control	Look up in Table 3-184	%	[534][535]
SF_{fuel}	Heating fuel percent savings from thermostat relative to baseline control.	Look up in Table 3-184	%	[534][535]
$EFLH_c$	Full load hours for cooling equipment	Look up in Appendix C:	Hrs/yr	[529]
$EFLH_h$	Full load hours for heating equipment	Look up in Appendix C:	Hrs/yr	[529]
CF	Electric coincidence factor	Look up in Table 3-185	N/A	
PDF	Gas peak day factor	Look up in Table 3-185	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Variable	Description	Value	Units	Ref
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-184 Saving Factors for Smart Thermostats by Baseline Technology

Fuel and Function	Baseline Technology		
	Manual Thermostat	Programmable Thermostat	Unknown
Savings factor for electric cooling, $SF_{elec,c}$	5%	3%	3%
Savings factor for electric heating, $SF_{elec,h}$	4%	2%	2%
Savings factor for fuel heating, SF_{fuel}	5%	2%	2%

Peak Factors

Table 3-185 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

In a retrofit scenario, this measure is being applied to existing operational equipment. Hence, the effective useful life (EUL) is the smaller of the host equipment remaining useful life (RUL) or 5 years [536]. If the host equipment RUL is unknown, assume 1/3 of of the host equipment EUL (look up in relevant HVAC measure).

In a time of sale/new construction scenario, the effective useful life (EUL) IS 7.5 years [533].

References

[529] Simulations of prototypical buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.

[530] ENERGY STAR's qualified products list for smart thermostats: https://data.energystar.gov/dataset/ENERGY-STAR-Certified-Connected-Thermostats/7p2p-wkbf

[531] ENERGY STAR Smart Thermostat Specification, from which most requirements based: https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Program%20Requirements%20for%20Connected%20Thermostats%20Version%201.0.pdf

[532] NEEP has developed a Guidance Document detailing methodology to claim savings from smart thermostats, available here: https://neep.org/sites/default/files/resources/ClaimingSavingsfromSmartThermostatsGuidanceDocumentFinal.pdf. This guidance uses the metric developed for the ENERGY STAR certification to develop geographically and

temporally specific savings averages for program claims. These calculated savings numbers are expected to be more accurate and potentially yield higher level of savings than the estimates provided in the TRM.

[533] Based on professional judgment of TRM technical team. EULs observed for residential applications include: 11 years in AR TRM and 10 years in IL TRM, both of which are based on programmable thermostat EULs. CA workpapers conclude 3-year EUL using persistence modeling. RTF concludes a 5-year EUL based on CA workpapers and concerns that there is little basis for assuming long-time persistence of savings, considering past challenges with manual overrides and “know-how” needed to use wifi-connected devices, including communicating hardware and software downloading. For discussion, see Northwest Regional Technical Forum April 2017. https://nwcouncil.box.com/v/ResConnectedTstatsv1-2

[534] The savings percentages claimed for manual thermostats include the savings associated with upgrading from manual thermostats to programmable thermostats, which a 2015 MEMD study reported as about 3% savings for gas customers and 2% savings for electric customers. http://www.michigan.gov/documents/mpsc/CI_Programmable_TStats_MEMD_6_15_15_491808_7.pdf

[535] Relative to a programmable thermostat, smart thermostats have savings opportunities available from a “smart recovery” function, which enables users to set the time they would like the building to reach a temperature as opposed to setting a time that the unit should start operating. Savings are also available from improved error detection and from locking out building occupants’ ability to override programmed schedules. Individual case studies have demonstrated savings in a variety of small commercial applications, but large-scale evaluations of smart thermostat savings have so far been limited to thermostats installed in residential applications. CLEAResult’s “Guide to Smart Thermostats” reports the ranges of savings measured in recent *residential* evaluations, relative to a baseline that blended programmable and manual thermostats: 10–13% for gas savings; 14–18% for electric cooling savings; and 6–13% for electric heating savings. https://www.clearesult.com/insights/whitepapers/guide-to-smart-thermostats/

[536] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.5.18 STEAM TRAP REPAIR/REPLACE

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Controls
Measure Last Reviewed	May 2023

Description

This measure covers the repair or replacement of leaking or blow-through steam traps in existing commercial steam systems served by fossil fuel-fired boilers. Steam traps that fail open allow excess steam to escape, thus increasing the amount of steam that must be generated to meet end-use requirements. This measure is intended for the repair or replacement of steam traps failed open only and requires the completion of a steam trap assessment to ensure the number of failed open steam traps are properly quantified. This measure does not apply to municipal steam systems. Energy savings from the installation of a stream trap monitoring system may not be claimed in conjunction with the saving presented in this measure.

The savings in this measure are per-steam trap. Savings should be multiplied by the total number of steam traps replaced. This measure is applicable to low pressure (≤15 psig) and high pressure (>15 psig) steam traps.

Baseline Case

The baseline case is the existing leaking or blow-through steam traps.

Efficient Case

The efficient case is the repaired or replaced steam traps.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = Loss_{steam} \times \frac{\Delta H_{vap}}{Eff} \times \frac{hrs}{1{,}000{,}000} \times F_{hrs} \times F_{CR}$$

Where,

$$Loss_{steam} = 60 \times \frac{\pi}{4} \times ID^2 \times psia^{0.97} \times F_{discharge} \times F_{loss}$$

$$psia = psig + p_{atm}$$

Annual Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times N/A$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-186 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Loss_{steam}$	Hourly steam loss per failed trap	Calculated	Lb/hr	
psia	Absolute steam pressure	Calculated	psi	
psig	Steam gauge pressure	Site-specific, if unknown look up in Table 3-188	psi	[537]
Eff	Thermal efficiency of boiler	Site-specific, if unknown look up in Table 3-188	Et or AFUE	[537]
Hrs	Annual hours trap pressurized	Site-specific, if unknown look up in Table 3-188	Hours	[537]
ID	Internial diameter of steam trap orifice	Site-specific, if unknown look up in Table 3-188	Inches	
F_{CR}	Condensate return factor, used to account for the proportion of energy lost that is returned to the system via condensate line	If no condensate return: 1.00 Otherwise, look up in Table 3-188	N/A	[537]
ΔH_{vap}	Heat of vaporization (latent heat) at system operating pressure	Look up in Table 3-187	Btu/lb	

Variable	Description	Value	Units	Ref
$F_{discharge}$	Discharge coefficient	Look up in Table 3-188	N/A	[537]
F_{loss}	Steam loss adjustment factor	Look up in Table 3-188	N/A	[537]
p_{atm}	Atmospheric pressure	14.7	psi	
60	Empirically derived constant in Grashof's equation	60	lbm/ $in^{0.06}$-$lb^{0.97}$-hr	[538]
π/4	Orifice area development factor	π/4	N/A	
0.97	Empirically derived constant in Grashof's equation	0.97	N/A	[538]
100,000	Conversion factor	100,000	Btu/therm	
PDF	Gas peak day factor	Lookup in Table 3-133	N/A	
EUL	Effective useful life	See Measure Life section	Years	

Table 3-187 Heat of Vaporization

Gauge Pressure (psig)	Heat of Vaporization (Btu/lb)	Gauge Pressure (psig)	Heat of Vaporization (Btu/lb)
0	970	8	956
1	968	9	954
2	966	10	953
3	964	11	951
4	962	12	950
5	961	13	948
6	959	14	947
7	957	15	946

Table 3-188 Default Steam Trap Parameters

Parameter	Low Pressure (≤15 psig)	High Pressure (>15psig)
Guage pressure (psig)	7.2	86.7
Orifice size (ID)	0.25	0.156
Annual hours	2,525	6,558
Boiler efficiency	0.80	0.80
Steam loss adjustment factor (F_{loss})	0.369	0.369

Parameter	Low Pressure (≤15 psig)	High Pressure (>15psig)
Discharge coefficient ($F_{discharge}$)	0.70	0.70
Condensate return factor (F_{CR})	0.363	0.363

Peak Factors

Table 3-189 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	Look up in Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 6 years [538].

References

[537] ERS, “Two-Tier Steam Trap Savings Study”, April 26, 2018. pg 5.

[538] Massachusetts Program Administrators and Energy Efficiency Advisory Council, “Steam Trap Evaluation Phase 2” March 8, 2017. Pg. 6.

3.5.19 MAINTENANCE

Market	Commercial/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Maintenance
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for existing HVAC tune ups in commercial applications. Efficiency of various HVAC Units degrades with age and a "tune-up" or preventative maintenance can help restore some of the lost efficiency.

For gas applications, a tune-up of non-residential fossil space heating boilers or furnaces involves cleaning and inspection, adjusting air flow, reduce stack temperatures (for boilers), and adjust burner input among other steps.

Electric Units such as Central A/C and heat pumps also benefit greatly from tune ups. A tune up typically includes air filter replacement, cleaning of coils and fans, repair of case insulation,refrigerant charge adjustments, and air flow adjustments. This measure only applies to central AC Systems or heat pumps of 20 tons (65,000 BTU/h) or less.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Gas: Commercial fossil space heating boiler or furnace that has not received a tune-up in 3 years or more.

Electric: An existing pre tune-up central A/C or heat pumpthat has not received a tune-up in 3 years or more.

Efficient Case

Gas: Commercial space heating boiler or furnace that has undergone a tune-up in accordance with the program requirements.

Electric: Central A/C System or heat pump after receiving tune up.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{Cool} + \Delta kWh_{Heat}$$

Where,

$$\Delta kWh_{Cool} = Cap_c \times EFLH_c \times \frac{1}{SEER_b} \times F_{improv}$$

$$\Delta kWh_{Heat} = Cap_h \times EFLH_h \times \frac{1}{HSPF_b} \times F_{Improv}$$

$$F_{improv} = \frac{Eff_{improv,q} - Eff_{improv,b}}{Eff_{improv,q}}$$

Annual Fuel Savings

For boilers,

$$\Delta Therms = \frac{Cap_{in}}{100} \times \left(1 - \frac{Eff_{c,b}}{Eff_{c,q}}\right) \times EFLH_h$$

For furnaces,

$$\Delta Therms = \frac{F_{furnace} \times Cap_{in} \times EFLH_h}{100}$$

Where,

$$F_{furnace} = \frac{Eff_{f,b} + \Delta Eff_{f,q}}{Eff_{f,b}} - 1$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{1}{EER_b} \times F_{improv} \times CF \times Cap_{in}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-190 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{cool}	Annual cooling energy savings	Calculated	kWh/yr	
ΔkWh_{heat}	Annual heating energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
F_{improv}	Percent improvement in EER/HSPF[105]	Calculated; if EER unknown look up in Table 3-191[106]	N/A	[539][543]
$Eff_{improv,b}$	EER/EER2 of existing AC Unit or HSPF of existing Heat pumps	Site-specific	EER: BTU/watts HSPF: BTU/watt-hr	
$Eff_{improv,q}$	EER/EER2 of efficient AC Unit or HSPF of efficient Heat pumps	Site-specific	EER: BTU/watts HSPF: BTU/watt-hr	
EER_b	EER or EER2 of existing AC Unit	Site-specific	BTU/watts	
Cap_c	Cooling Capacity of existing AC Unit	Site-specific	kBTU/hr	
Cap_h	Heating Capacity of existing Heat Pumps	Site-specific	kBTU/hr	
Cap_{in}	Fuel input rating per boiler/furnace	Site-specific	kBTU/hr	
$Eff_{c,b}$	Baseline combustion efficiency as determined via flue gas analysis	Site-specific	N/A	
$Eff_{c,q}$	Post-implementation boiler combustion efficiency as determined via flue gas analysis	Site-specific	N/A	

[105] For heat pumps: HSPF = COP x 3.413, where COP is coefficient of performance

[106] IL TRM derives savings estimates by applying the findings from DNV-GL "Impact Evaluation of 2013-2014 HVAC3 Commercial Quality Maintenance Programs", April 2016, to simulate the inefficient condition within select eQuest models and across climate zones. The percent savings were consistent enough across building types and climate zones that it was determined appropriate to apply a single set of assumptions for all. See 'eQuest C&I Tune up Analysis.xlsx' for more information.

Variable	Description	Value	Units	Ref
$Eff_{f,b}$	Actual combustion efficiency of the furnace before tune-up, based on flue gas analysis	Site-specific	N/A	
$Eff_{f,q}$	Post-implementation furnace combustion efficiency as determined via flue gas analysis	Site-specific	N/A	
$EFLH_c$	Equivalent Full Load Hours of operation for the average unit during the cooling season	See Appendix C:	Hours	[540]
$EFLH_h$	Equivalent Full Load Hours of operation for the average unit during the heating season	See Appendix C:	Hours	[540]
$SEER_b$	SEER or SEER2 of actual unit, before the tune-up	Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies	Btu/W-h	
100	Conversion from kBtu to therms	100	kBtu/Therms	
$F_{furnace}$	Energy Savings Factor furnace	For Large Commercial - Calculated; For Small Commercial (<225 MBH) = 0.05	N/A	[541]
CF	Electric coincidence factor (CF)	Look up in Table 3-192	N/A	[543]
PDF	Gas peak demand factor	Look up in Table 3-192	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-191 Percent Improvement in EER (F_{improv})

Maintenance or Tune-Up Component	% Savings
Condenser Cleaning	6.10
Evaporator Cleaning	0.22
Refrigeration Charge Offset <=20%	0.68
Refrigeration Charge Offset >20%	8.44

Peak Factors

Table 3-192 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.478	[543]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Measure Life for HVAC tune-up /maintenance measures is 3 yrs [542].

References

[539] Energy Center of Wisconsin, *Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research* (May 2008)

[540] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[541] Washington State University Energy Program, Building Tune-Up and Operations Program Evaluation (March 2007), Pg 5

[542] DEER 2014 EUL http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

[543] *2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0 Volume 2: Commercial and Industrial Measures* (2022), Pg 221-223 https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf

3.5.20 ADVANCED ROOFTOP CONTROLS

Market	Commercial/Multifamily
Measure Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Controls
Measure Last Reviewed	November 2022

Description

This measure covers the installation of advanced rooftop unit control (ARC) on a constant volume rooftop HVAC unit with a single-speed supply fan. This involves the following 3 components, adding demand-controlled ventilation (DCV), Dual enthalpy economizers, and a supply fan with a variable frequency drive (VFD). DCV systems monitor the CO_2 levels and accordingly vary the supply outdoor air as needed, resulting in the reduction of heating and cooling loads. Dual enthalpy economizers reduce cooling loads by supplying outside air to the space when the outside air is deemed suitable for cooling. Multi/variable-speed fan motors reduce the fan speed for first stage cooling and ventilation.

Saving factors were calculated based on IL TRM values for Chicago, adjusted by ratio of Degree Days for each listed NJ Climate Zone and Chicago, based on TMY 3 Data using base 65 F balance point. See the 'Demand Controlled Ventilation' Section of the Illinois Statewide Technical Reference Manual V11 for further explanation [546].

It is important to note that only those components that are not required by code are eligible for savings.

Baseline Case

Constant volume rooftop HVAC unit with a single-speed supply fan and no occupancy-based ventilation or functioning airside economizer

Efficient Case

Rooftop HVAC Unit with an advanced rooftop unit controller added providing DCV, VFD fan speed controls, and dual enthalpy air-side economizer control

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{fan} + \Delta kWh_{DCV} + \Delta kWh_{Econ}$$

Where

$$\Delta kWh_{fan} = hp \times ESF_{fan} \times hrs$$

$$\Delta kWh_{DCV} = \frac{A}{1{,}000} \times SF_{ElecCool} + \frac{A}{1{,}000} \times SF_{ElecHeat} \times F_{ElecHeat}$$

$$\Delta kWh_{Econ} = tons \times SF_{Econ}$$

Annual Fuel Savings

$$\Delta Therms = \frac{A}{1{,}000} \times SF_{fuel} \times F_{FuelHeat}$$

Peak Demand Savings

$$\Delta kW_{Peak} = hp \times ESF_{fan} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therm \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-193 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	

Variable	Description	Value	Units	Ref
ΔkWh_{fan}	Annual electricity energy savings resulting from supply fan control	Calculated	kWh/yr	
ΔkWh_{DCV}	Annual electricity energy savings resulting from DCV	Calculated	kWh/yr	
ΔkWh_{Econ}	Annual electricity energy savings resulting from economizer	Calculated	kWh/yr	
hp	Horsepower of RTU supply fan	Site-specific	hp	
ESF_{fan}	Energy savings factor for supply fan control[107]	0.580	kWh/hp/hr	[544]
hrs	Annual operating hours of RTU supply fan	Site-specific if unknown use default values in Table 3-194	Hrs/yr	[545]
A	Total area square footage of the conditioned space impacted by the measure	Site-specific	Ft^2	
$SF_{ElecCool}$	DCV energy savings factor for cooling	Look up in Table 3-195	kWh/1,000 ft^2	[546]
$SF_{ElecHeat}$	DCV energy savings factor for electric heating	Look up in Table 3-196, Table 3-197	kWh/1,000 ft^2	[546]
$F_{elecHeat}$	Electric heating factor, used to account for the presence or absence of an electric heating system	1 (if electric heat) 0 (otherwise)	N/A	
tons	Tons of air conditioning supplied by RTU, based on nameplate data	Site-specific	tons	
SF_{econ}	Annual electric energy savings per ton of cooling resulting from economizer	Look up in Table 3-199	kWh/ton	[547]
SF_{Fuel}	DCV fuel savings factor for heating	Look up in Table 3-198	therms/1,000 ft^2	[546]
$F_{FuelHeat}$	Fuel heating factor, used to account for the presence or absence of a fossil fuel heating system	1 (if fossil fuel heat) 0 (otherwise)	N/A	
CF	Electric coincidence factor	Look up in Table 3-200	N/A	[548]
PDF	Gas peak day factor	Look up in Table 3-200	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

[107] Unweighted average of kWh/hp/hour fan savings across all test cases in Advanced Rooftop Control (ARC) Retrofit: Field-Test Results, PNNL22656, Table 10: TMY weather normalized annual savings for all units. Fan Energy Savings (kWh) is divided by RTU Fan Power (hp) and Annual RTU Running Time (hr) to determine Energy Savings Factor for supply fan controls (kWh/hp/hr)

Table 3-194 Hours of Use Based on Building Type

Building Type	Hours
Office – Small Commercial	2,950
Office – Large Commercial	2,969
Religious Building	4,573
Restaurant	4,573
Retail - Department Store	4,920
Retail – Strip Mall	4,926
Grocery	7,134
School	2,575
Healthcare Clinic	3,909
Hospital	8,760
Lodging (Hotel/Motel)	4,573
Multifamily – Common Areas	5,950
Multifamily – In-Unit	679
Warehouse – Small Commercial	3,799
Warehouse – Large Commercial/Industrial	4,116
Other	4,573
Enclosed Parking Garage	3,338

Table 3-195 Energy Savings Factor for Cooling Associated with DCV (kWh/1,000 SF)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Low-rise (1 to 3 Stories)	267	362	368	366	359	334
Office - Mid-rise (4 to 11 Stories)	211	286	291	289	283	264
Office - High-rise (12+ Stories)	250	340	345	344	337	314
Religious Building	720	978	994	989	970	903
Restaurant	471	640	650	647	634	590
Retail - Department Store	363	493	501	498	489	455
Retail - Strip Mall	251	341	347	345	338	315
Convenience Store	330	448	455	453	444	413

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Elementary School	339	460	468	465	456	425
High School	332	450	457	455	446	415
College/ University	393	534	543	540	530	493
Healthcare Clinic	327	444	451	449	440	410
Lodging (Hotel/Motel)	378	513	521	518	508	473
Manufacturing	163	222	226	224	220	205
Special Assembly Auditorium	537	729	740	737	722	672
Other	356	483	491	488	479	446
Enclosed Parking Garage	854	1,160	1,179	1,173	1,150	1,070

Table 3-196 Electric Heating Savings with Heat Pump Associated with DCV (kWh/1,000 SF)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Low-rise (1 to 3 Stories)	185	149	163	158	163	167
Office - Mid-rise (4 to 11 Stories)	125	100	110	106	109	112
Office - High-rise (12+ Stories)	167	135	147	143	147	151
Religious Building	1206	970	1062	1028	1057	1087
Restaurant	870	700	767	742	763	785
Retail - Department Store	298	239	262	254	261	268
Retail - Strip Mall	194	156	171	166	171	175
Convenience Store	147	119	130	126	129	133
Elementary School	517	416	456	441	454	467
High School	505	406	445	430	443	455
College/ University	1007	811	888	859	884	909
Healthcare Clinic	358	288	316	305	314	323
Lodging (Hotel/Motel)	166	134	147	142	146	150
Manufacturing	103	83	91	88	90	93
Special Assembly Auditorium	1414	1138	1246	1207	1241	1276
Other	484	389	426	413	424	436
Enclosed Parking Garage	185	149	163	158	163	167

Table 3-197 Electric Heating Savings with Electrical Resistance Associated with DCV (kWh/1,000 SF)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Low-rise (1 to 3 Stories)	556	448	490	474	488	493
Office - Mid-rise (4 to 11 Stories)	374	301	329	319	328	331
Office - High-rise (12+ Stories)	501	403	441	427	439	443
Religious Building	3617	2910	3186	3085	3172	3202
Restaurant	2610	2100	2300	2226	2289	2311
Retail - Department Store	893	718	786	761	783	790
Retail - Strip Mall	584	470	515	498	512	517
Convenience Store	441	355	389	376	387	391
Elementary School	1551	1248	1367	1323	1360	1374
High School	1513	1218	1333	1291	1327	1340
College/ University	3022	2432	2662	2577	2650	2676
Healthcare Clinic	1074	865	947	916	942	952
Lodging (Hotel/Motel)	498	401	439	425	437	441
Manufacturing	310	250	273	265	272	275
Special Assembly Auditorium	4242	3414	3738	3619	3721	3757
Other	1452	1169	1280	1239	1274	1286

Table 3-198 Fuel Heating Savings Associated with DCV (therm/1,000 SF)

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Office - Low-rise (1 to 3 Stories)	24	19	21	20	21	21
Office - Mid-rise (4 to 11 Stories)	16	13	14	14	14	14
Office - High-rise (12+ Stories)	22	17	19	19	19	19
Religious Building	155	124	136	132	136	137
Restaurant	111	90	98	95	98	99
Retail - Department Store	38	31	33	32	33	33
Retail - Strip Mall	25	20	22	22	22	22
Convenience Store	19	15	17	16	17	17
Elementary School	66	53	58	56	58	58
High School	64	52	57	55	56	57
College/ University	129	104	114	110	113	114

Building Type	North	Coastal	Central	Pine Barrens	Southwest	Statewide Average
Healthcare Clinic	46	37	41	39	40	41
Lodging (Hotel/Motel)	21	17	18	18	18	18
Manufacturing	14	11	12	12	12	12
Special Assembly Auditorium	181	146	159	154	159	160
Other	61	49	54	52	54	54

Table 3-199 Economizer Savings kWh Per Cooling Ton

Building Type	$(kWh/ton)_{Econ}$
Office	186
Religious Building	6
Restaurant – Full-Service	31
Restaurant – Fast Food	39
Retail - Department Store	152
Retail – Strip Mall	95
Convenience Store	95
Elementary School	42
High School	61
College/University	61
Healthcare Clinic	61
Lodging (Hotel/Motel)	61
Manufacturing	25
Special Assembly Auditorium	27
Warehouse	2
Other	61

Peak Factors

Table 3-200 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[548]

Peak Factor	Value	Ref
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-201 Measure Life

Equipment	EUL	RUL	Ref
Advanced Rooftop Controls	5	1.67	[549]

References

[544] *Advanced Rooftop Control (ARC) Retrofit: Field-Test Results.* (US DOE 2013) Table 10, https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22656.pdf

[545] Navigant, *EmPOWER Maryland DRAFT Final Impact Evaluation Deemed Savings (June 1,2017 – May 31, 2018) Commercial & Industrial Prescriptive, Small Business, and Direct Install Programs*, (2018)

[546] Saving factors were calculated based on IL TRM values for Chicago, adjusted by ratio of Degree Days for each listed NJ Climate Zone and Chicago, based on TMY 3 Data using base 65 F balance point. *2023 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 11 Volume 2: Commercial and Industrial Measures* (September 2022), Pg 357, https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010123_v11.0_Vol_2_C_and_I_092222_FINAL.pdf

[547] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 10*. (New York State Joint Utilities, 2023), Appendix J Pg 1279-1280 https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

[548] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 10. (New York State Joint Utilities, 2023), Pg 818 https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

[549] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Version 10. (New York State Joint Utilities, 2023), Pg 1366 https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

3.6 SHELL

3.6.1 HIGH-RISE MULTIFAMILY AIR SEALING

Market	Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Shell
Measure Last Reviewed	January 2023

Description

This section provides energy savings algorithms for the sealing air leakage paths to reduce the natural air infiltration rate through the installation of products and repairs to the building envelope. It is assumed that air sealing is the first priority among candidate space conditioning measures. Expected percentage savings is based on previous experiences with measured savings from similar programs.

The method below only applies to high-rise multifamily applications where blower door testing is not conducted.

Baseline Case

The baseline case is a building envelope with natural air infiltration through air leakage paths.

Efficient Case

The exterior envelope, as well as interior walls/partitions between conditioned and unconditioned spaces should be inspected and all gaps sealed. At a minimum, the following items shall be inspected, and sealing measures may be implemented based upon inspection results:

- Caulk and weather strip doors and windows that leak air
- Repair or replace doors leading from conditioned to unconditioned space
- Seal air leaks between unconditioned (including unconditioned basement and attics) and conditioned spaces to include, but not limited to, plumbing, ducting, electrical wiring, wall top plates, chimneys, flues, and dropped soffits
- Use foam sealant on larger gaps around windows, baseboards, and other places where air leakage, either infiltration or exfiltration may occur

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{SF}{1{,}000} \times \left(\frac{\Delta kWh}{1{,}000\ ft^2}\right)$$

ΔAnnual Fuel Savings

$$\Delta Therms = \frac{SF}{1{,}000} \times \left(\frac{\Delta Therms}{1{,}000\ ft^2}\right)$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{SF}{1{,}000} \times \left(\frac{\Delta kW}{1{,}000\ ft^2}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-202 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
SF	Building square feet of conditioned floor area affected by installation	Site-specific	ft^2	
$\frac{\Delta kWh}{1{,}000\ ft^2}$	Annual electric energy savings per thousand square feet	Lookup Table 3-203	kWh/ft^2	[551]
$\frac{\Delta kW}{1{,}000\ ft^2}$	Peak coincident demand electric savings per thousand square feet	Lookup Table 3-203	kWh/ft^2	[551]
$\frac{\Delta Therms}{1{,}000\ ft^2}$	Annual gas energy savings per thousand square feet	Lookup Table 3-203	$Therms/\ ft^2$	[551]
1,000	Conversion Factor from square feet (SF) to 1,000 square feet (kSF)	1000	N?A	

Variable	Description	Value	Units	Ref
CF	Coincidence factor	Lookup in Table 3-204	N/A	
PDF	Gas peak day factor	Lookup in Table 3-204	N/A	
EUL	Effective useful life	See Measure Life section	Years	

Table 3-203 Impact per thousand square feet[108]

Vintage	$\frac{\Delta kWh}{1,000\ ft^2}$	$\frac{\Delta kW}{1,000\ ft^2}$	$\frac{\Delta Therms}{1,000\ ft^2}$
Old	118	0.119	29
Average	56	0.098	17

Peak Factors

Table 3-204 Peak Factors

Peak Factor	Value	Ref
Coincidence factor	0.69	[552]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 15 years [550].

References

[550] GDS Associates, Inc. Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures. 2007. https://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf

[551] New York State Joint Utilities, New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, V10, pg. 1222, January 2023.

[552] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011 and supported by research conducted by Cadmus on behalf of the RM Management Committee.

[108] The baseline infiltration rate for old building is 1.0 ACH and average building is 0.5 ACH. The energy savings are based on a 15% reduction.

3.7 LIGHTING

3.7.1 LIGHTING FIXTURES

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/DI
Baseline	Code/Existing/Dual
End Use Subcategory	Lighting Fixtures
Measure Last Reviewed	November 2022

Description

This section provides energy savings algorithms for qualifying lighting improvements implemented in commercial and industrial settings. This measure includes both retrofit of existing lamps and new construction projects. For in-unit lamps and lamps installed in common areas of multifamily low-rise buildings, refer to the Residential Section. For lamps/fixtures intalled in common areas of multifamily high-rise buildings, use the algorithms below.

Replacement programs includes fixture replacements for existing commercial and industrial customers. It is targeted for facilities performing efficiency upgrades to their lighting systems. New fixtures and technologies available after publication will be periodically updated. Baselines will be established based on the guidelines noted below.

For new construction and entire facility rehabilitation projects, savings are calculated by comparing the lighting power density (LPD) of fixtures being installed to the baseline LPD, or “lighting power allowance,” from the building code. For the state of New Jersey, the applicable building code is IECC 2021 [554].

For interior lighting power allowance, ASHRAE 90.1 allows either a space by space method or a building area method to calculate the overall lighting power allowance. The space by space method involves applying a different LPD for each space using values from Table 3-207 whereas the building area method involves applies applying a uniform LPD to the entire building using values from Table 3-206.

The exterior lighting power allowance is calculated as follows.

1. Determine the lighting zone from Table 3-208.
2. Determine the applicable category and space type from Table 3-209
3. Based on lighting zone, category, and space type, determine the applicable exterior LPD.
4. The LPD is multiplied with the appropriate unit to get lighting power allowance.

There are 2 types of surfaces in Table 3-209, tradable and non tradable surfaces. Tradable surfaces are surfaces where if you don’t use all the lighting allowed on one of the surfaces you can use the left over on another one of the tradable surfaces. Non-tradable surfaces are allowed a certain amount of lighting and you cannot use the excess somewhere else nor can you use excess from somewhere else on these surfaces.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

New Construction Interior Lighting: Baseline lighting LPD based on the IECC 2021 Code [554] with adjustments for standard practice [7].

New Construction Exterior Lighting: Baseline lighting LPA based on the IECC 2021 Code [554] with adjustments for standard practice [7].

Replacement: Actual existing fixture/lamp wattage. If unknown, use wattage from National Grid Fixture Wattage Table, 2015 [553].

Mid-Stream Lighting: Lookup in Appendix L: Lighting Wattages

Efficient Case

New Construction Interior Lighting: LPD of qualified fixtures, equal to the sum of installed fixture wattage divided by floor area of the space where the fixtures are installed.

New Construction Exterior Lighting: LPA of qualified fixtures, equal to the sum of installed fixture wattage

Retrofit: Wattage of new fixture.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

New Construction Interior Lighting:

$$\Delta kWh = \frac{LPD_b \times LPD_{AF} - LPD_q}{1{,}000} \times A \times Hrs \times (1 + HVAC_e)$$

New Construction Exterior Lighting:

$$\Delta kWh = \frac{\left(LPA_b \times LPA_{AF} - LPA_q\right)}{1{,}000} \times AL \times Hrs$$

Replacement/Midstream Interior Lighting:

$$\Delta kWh = \frac{Qty_b \times W_b - Qty_q \times W_q}{1{,}000} \times Hrs \times (1 + HVAC_e)$$

Replacement/Midstream Exterior Lighting:

$$\Delta kWh = \frac{Qty_b \times W_b - Qty_q \times W_q}{1{,}000} \times Hrs$$

Annual Fuel Savings

Replacement/Midstream Interior Lighting:

$$\Delta Therms = \frac{\left(Qty_b \times W_b - \ Qty_q \times W_q\right)}{1{,}000} \times Hrs \times HVAC_g \times 10$$

New Construction Interior Lighting:

$$\Delta Therms = \frac{LPD_b \times LPD_{AF} - LPD_q}{1{,}000} \times A \times Hrs \times HVAC_g \times 10$$

Note: *No fuel impacts are claimed in exterior lighting installation.*

Peak Demand Savings

Retrofit Interior Lighting:

$$\Delta kW_{Peak} = \frac{Qty_b \times W_b - \ Qty_q \times W_q}{1{,}000} \times CF \times (1 + HVAC_d)$$

Retrofit Exterior Lighting:

$$\Delta kW_{Peak} = \frac{Qty_b \times W_b - \ Qty_q \times W_q}{1{,}000} \times CF$$

New Construction Interior Lighting:

$$\Delta kW_{Peak} = \frac{LPD_b \times LPD_{AF} - LPD_q}{1{,}000} \times A \times CF \times (1 + HVAC_d) \times (1 + SVG_b)$$

New Construction Exterior Lighting

$$\Delta kW_{peak} = \frac{\left(LPA_b \times \ LPA_{AF} - LPA_q\right)}{1{,}000} \times AL \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \ \Delta Therms * PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-205 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
Qty_b	Quantity of replaced fixtures	Site-specific	N/A	
Qty_q	Quantity of qualifying fixtures	Site-specific	N/A	
W_b	Wattage of baseline fixture	Site-specific, if unknown see Appendix L: Lighting Wattages	W	[553]
W_q	Wattage of qualifying fixture (per DLC or ENERGY STAR certification, or manufacturer's cutsheet if certification not required by program)	Site-specific	W	
LPD_q	Installed lighting power density	Site-specifiic	W/Sq Ft	
LPD_b	Baseline lighting power density	Site-specific, if unknown look up in Table 3-206, Table 3-207, Table 3-209	W/Sq Ft	
LPA_b	Baseline lighting power allowance	Site-specific, if unknown look up in Table 3-209	W/Sq Ft or W/ Linear Ft	[554]
LPA_q	Installed lighting power allowance	Site-specific, if unknown look up in Table 3-209	W/Sq Ft or W/ Linear Ft	[554]
AL	If LPA unit is W/Sq Ft: AL is Area If LPA Unit is W/linear ft: AL is linear ft	Site-specific	Sq Ft or Linear Ft	
A	Area in Square Feet	Site-Specific	Square Foot	
Hrs	Annual Hours of Operation	Site-specific, if unknown use Table 3-210	Hrs/yr	[545]
LPD_{AF} (interior)	Interior Lighting LPD adjustment factor (25% better)	0.75	N/A	[559]

Variable	Description	Value	Units	Ref
LPA_{AF} (exterior)	Exterior Lighting LPA adjustment factor (35% better)	0.65	N/A	[559]
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 3-211	N/A	[576][578]
$HVAC_g$	HVAC Interactive Factor for Annual Fuel Savings	Look up in Appendix F: HVAC Interactivity Factors	MMBtu/kwh	[563]
$HVAC_d$	HVAC Interactive Factor for Peak Demand Savings	Look up in Table 3-211	N/A	[576][578]
CF	Coincidence Factor	Look up in Table 3-210	N/A	[545]
SVG_b	Savings control factor	Look up in Table 3-212		[562]
PDF	Gas peak day factor	Look up in Table 3-213		
RUL	Remaining useful life of existing equipment	Site-specific, if unknown use EUL/3	Years	
EUL	Effective useful life of new measure	See Measure Life Section	Years	
1,000	Conversion from watts to kW	1,000	W/kW	
10	Conversion from MMBtu to therms	10	Therms/MMBtu	

Table 3-206 Baseline Lighting Power Density (Building Area Method) – IECC 2021 Standard Section C405.3.2(1) [554]

Building Area Type	LPD (Watts/ft²)	Building Area Type	LPD (Watts/ft²)
Automotive facility	0.75	Multifamily	0.45
Convention center	0.64	Museum	0.55
Court house	0.79	Office	0.64
Dining: bar lounge/leisure	0.80	Parking garage	0.18
Dining: cafeteria/fast food	0.76	Penitentiary	0.69
Dining: family	0.71	Performing arts theatre	0.84
Dormitory	0.53	Police/fire station	0.66
Exercise center	0.72	Post office	0.65
Fire station	0.56	Religious building	0.67
Gymnasium	0.76	Retail	0.84
Health care clinic	0.81	School/university	0.72
Hospital	0.96	Sports arena	0.76

Building Area Type	LPD (Watts/ft²)	Building Area Type	LPD (Watts/ft²)
Hotel/motel	0.56	Town hall	0.69
Library	0.83	Transportation	0.50
Manufacturing facility	0.82	Warehouse	0.45
Motion picture theatre	0.44	Workshop	0.91

Table 3-207 Baseline Lighting Power Density (Space by Space Method) 2021 IECC section C405.3.2(2) [2]

Space Types	LPD (watts/ft²)	Space Types	LPD (watts/ft²)
Atrium		**Laundry/washing area**	0.53
Less than 40 feet in height	0.48	**Library**	
Greater than 40 feet in height	0.6	*In a reading area*	0.96
Audience seating area		*In the stacks*	1.18
In an auditorium	0.61	**Loading dock, interior**	0.88
In a gymnasium	0.23	**Lobby**	
In a motion picture theater	0.27	*For an elevator*	0.65
In a penitentiary	0.67	*In a facility for the visually impaired (and not used primarily by the staff)[b]*	1.69
In a performing arts theater	1.16	*In a hotel*	0.51
In a religious building	0.72	*In a motion picture theater*	0.23
In a sports arena	0.33	*In a performing arts theater*	1.25
Otherwise	0.33	*Otherwise*	0.84
Automotive (see Vehicular maintenance area)		**Locker room**	0.52
Banking activity area	0.61	**Lounge/breakroom**	
Breakroom (See Lounge/breakroom)		*In a healthcare facility*	0.42
Classroom/lecture hall/training room		*Otherwise*	0.59
In a penitentiary	0.89	**Manufacturing facility**	
Otherwise	0.71	*In a detailed manufacturing area*	0.8
Computer room, data center	0.94	*In an equipment room*	0.76
Conference/meeting/multipurpose room	0.97	*In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)*	1.42
Convention Center—exhibit space	0.61	*In a high-bay area (25–50 feet floor-to-ceiling height)*	1.24
Copy/print room	0.31	*In a low-bay area (less than 25 feet floor-to-ceiling height)*	0.86
Corridor		**Museum**	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71	*In a general exhibition area*	0.31
In a hospital	0.71	*In a restoration room*	1.1
Otherwise	0.41	**Office**	
Courtroom	1.2	*Enclosed*	0.74

Space Types	LPD (watts/ft²)
Dining area	
In bar/lounge or leisure dining	0.86
In cafeteria or fast food dining	0.4
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.27
In family dining	0.6
In a penitentiary	0.42
Otherwise	0.43
Dormitory—living quarters[c, d]	0.5
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.7
In a recreation room (and not used primarily by the staff)	1.77
Fire Station—sleeping quarters[c]	0.23
Food preparation area	1.09
Guestroom[c, d]	0.41
Gymnasium/fitness center	
In an exercise area	0.9
In a playing area	0.85
Healthcare facility	
In an exam/treatment room	1.4
In an imaging room	0.94
In a medical supply room	0.62
In a nursery	0.92
In a nurse's station	1.17
In an operating room	2.26
In a patient room[c]	0.68
In a physical therapy room	0.91
In a recovery room	1.25
Laboratory	
In or as a classroom	1.11
Otherwise	133

Space Types	LPD (watts/ft²)
Open plan	0.61
Parking area, interior	0.15
Pharmacy area	1.66
Performing arts theater—dressing room	0.41
Post office—sorting area	0.76
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.85
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	1.26
Otherwise	0.63
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	0.82
Sales area	1.05
Seating area, general	0.23
Stairwell	0.49
Sports arena—playing area	
For a Class I facility[e]	2.94
For a Class II facility[f]	2.01
For a Class III facility[g]	1.3
For a Class IV facility[h]	0.86
Storage room	0.38
Transportation facility	
At a terminal ticket counter	0.51
In a baggage/carousel area	0.39
In an airport concourse	0.25
Vehicular maintenance area	0.6
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69
Workshop	1.26

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

d. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

e. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

f. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

g. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

h. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

Table 3-208 Exterior Lighting Zones - 2021 IECC section C405.5.2 (1)

Lighting Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use, and residential mixed-use areas
3	All other areas not classified as Lighting Zone 1, 2, or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

Table 3-209 Exterior Lighting Power Allowances – 2021 IECC Standard Section C405.5.2(2) and Section C405.5.2(3)

Category		Space	Units	Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance			W	350	400	500	900
Tradable Surfaces	Uncovered Parking Areas	Parking areas and drives	W/ft²	0.03	0.04	0.06	0.08
	Building Grounds	Walkways and ramps less than 10 feet wide	W/Linear Foot	0.50	0.50	0.60	0.70
	Building Grounds	Walkways and ramps 10 feet wide or greater, plaza areas	W/ft²	0.10	0.10	0.11	0.14
	Building Grounds	Dining areas	W/ft²	0.65	0.65	0.75	0.95
	Building Grounds	Stairways	W/ft²	0.60	0.70	0.70	0.70
	Building Grounds	Pedestrian tunnels	W/ft²	0.12	0.12	0.14	0.21
	Building Grounds	Landscaping	W/ft²	0.03	0.04	0.04	0.04
	Building Entrances and Exits	Pedestrian and vehicular entrances and exits	W/Linear Foot of opening	14	14	21	21
	Building Entrances and Exits	Entry canopies	W/ft²	0.20	0.25	0.40	0.40
	Building Entrances and Exits	Loading docks	W/ft²	0.35	0.35	0.35	0.35
	Sales Canopies	Canopies (free-standing and attached)	W/ft²	0.40	0.40	0.6	0.7
	Outdoor Sales	Open areas (including vehicle sales lots)	W/ft²	0.20	0.20	0.35	0.50
	Outdoor Sales	Street frontage for vehicle sales lots in addition to "Open Area" allowance	W/Linear Foot	-	7	7	21
No	Building facades		W/ft² of gross above-grade wall area	-	0.075	0.113	0.15

Category	Space	Units	Zone 1	Zone 2	Zone 3	Zone 4
	Automated teller machines (ATMs) and night depositories	W per location	135 plus 45 per additional ATM	135 plus 45 per additional ATM	135 plus 45 per additional ATM	135 plus 45 per additional ATM
	Uncovered entrances and gatehouse inspection stations at guarded facilities	W/ft^2	0.5	0.5	0.5	0.5
	Uncovered loading areas for law enforcement, fire, ambulance, and other emergency vehicles	W/ft^2	0.35	0.35	0.35	0.35
	Drive-up windows and doors	W/drive-through	200	200	200	200
	Parking near 24-hour retail entrances	W/main entry	400	400	400	400

Table 3-210 Hours of Use and Coincidence Factor by Building Type

Building Type	Sector	CF	Hours
Grocery	Large Commercial/Industrial & Small Commercial	0.96	7,134
Medical – Clinic	Large Commercial/Industrial & Small Commercial	0.8	3,909
Medical - Hospital	Large Commercial/Industrial & Small Commercial	1	8,760[109]
Office	Large Commercial/Industrial	0.7	2,969
	Small Commercial	0.67	2,950
Other	Large Commercial/Industrial & Small Commercial	0.66	4,573
Retail	Large Commercial/Industrial	0.96	4,920
	Small Commercial	0.86	4,926
School	Large Commercial/Industrial & Small Commercial	0.50	2,575
Warehouse/ Industrial	Large Commercial/Industrial	0.7	4,116
	Small Commercial	0.68	3,799
Outside/Outdoor Area	All	0.11	3,604
Parking Garage	All	0.98	8,678
Multifamily – Common Areas[110]	Multifamily	0.86	5,950
Multifamily – In-Unit	Multifamily	0.06	679
Multifamily –Exterior	Multifamily	0.00	3,338

[109] Assumes hospital operations are year round.
[110] NEEP Mid-Atlantic TRM V9, p. 24.

Building Type	Sector	CF	Hours
College/University - Cafeteria[111]	All	0.79	2,713
College/University – Classes[3]	All	0.54	2,586
College/University - Dormitory[3]	All	0.92	3,066
Religious Building[3]	All	0.89	1,955
Nursing Home[3]	All	0.92	5,840
Restaurant - Dine-In[111]	All	0.79	4,182
Restaurant - Fast food[111]	All	0.79	6,456
Museum[111]	All	0.89	3,748

Table 3-211 HVAC Interactive Effects[112]

Building Type	HVAC Interactive Factor for Peak Demand Savings ($HVAC_d$)		HVAC Interactive Factor for Annual Energy Savings ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/NonElec	AC/ElecRes	Heat Pump	NoAC/ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Mid-Stream/Other[113]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Table 3-212 Baseline SVG Values

Building Type	SVGbase
Education	17%
Exterior	0%
Grocery	5%

[111] From NY TRM V10, Pg 862
[112] These values only apply for conditioned spaces. For unconditioned spaces, the ineractive factors are equal to zero.
[113] The 'Other' building type should be used when the building type is known but not explicitly listed above. A description of the actual building type should be recorded in the project documentation. For multifamily high-rise building common areas, use this type. For in unit lamps/fixtures and multifamily low-rise building common areas refer to the Residential Section.

Health	8%
Industrial/Manufacturing – 1 Shift	0%
Industrial/Manufacturing – 2 Shift	0%
Industrial/Manufacturing – 3 Shift	0%
Institutional/Public Service	12%
Lodging	15%
Miscellaneous/Other	6%
Office	15%
Parking Garage	0%
Restaurant	5%
Retail	5%
Warehouse	14%
Custom	Based on Code

Peak Factors

Table 3-213 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Look up in Table 3-210	[545]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Table 3-214 Measure Life (EUL)

Equipment Type	Baseline Type = RF, DI	Baseline Type = NC	Ref
LED Fixture	5.4	Fixture rated life / operating hours (Table 1-6). Not to exceed 15 yr.	[560]
LED Fixture with Controls	6.6	Fixture rated life / operating hours (Table 1-6). Not to exceed 15 yr.	[560]
TLED	5.2	N/A	[560]
High Bay/Low Bay LED Fixture	6.6	Fixture rated life / operating hours (Table 1-6). Not to exceed 15 yr.	[560]
High Bay/Low Bay LED Fixture with Controls	7.6	Fixture rated life / operating hours (Table 1-6). Not to exceed 15 yr.	[560]
High Bay/Low Bay TLED	6.2	N/A	[560]

Equipment Type	Baseline Type = RF, DI	Baseline Type = NC	Ref
Exterior/Outdoor LED Fixture	6.6	Fixture rated life / operating hours (Table 1-6). Not to exceed 15 yr.	[560]
Exterior/Outdoor LED Fixture with Controls	7.6	Fixture rated life / operating hours (Table 1-6). Not to exceed 15 yr.	[560]
Exterior/Outdoor TLED	6.2	N/A	[560]
Screw-in LEDs	1	N/A	[561]

References

[553] Review of Device Codes and Rated Lighting System Wattage Table Retrofit Program. 2015. National Grid. January 13, 2015. https://www.nationalgridus.com/non_html/2010_Retrofit_Lighting_DeviceCodes_RI.pdf

[554] "2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES." n.d. Codes.iccsafe.org. Accessed November 16, 2022. https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency.

[555] Navigant, *EmPOWER Maryland DRAFT Final Impact Evaluation Deemed Savings (June 1,2017 – May 31, 2018) Commercial & Industrial Prescriptive, Small Business, and Direct Install Programs*, (2018)

[556] Navigant, *EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs*, (2013)

[557] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*

[558] Northeast Energy Efficiency Partnerships & KEMA, *C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum.* (2011).

[559] DNV, *New Jersey Commercial New Construction Industry Standard Practice Analysis. Prepared for Rutgers University and the NJ Board of Public Utilities.* (2022).

[560] DNV, N*ew Jersey Non-Residential Lighting Market Characterization*. *Prepared for Rutgers University and the NJ Board of Public Utilities.* (2022).

[561] Engineering judgement based on expected existing incandescent or halogen lamp remaining life. Once the existing lamp has burned out, replacement with an EISA-compliant lamp is assumed to be the only option.

[562] *Technical Reference Manual Volume 3: Commercial and Industrial Measures* (August 2019) Pg 21 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[563] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

3.7.2 LIGHTING CONTROLS

Market	Commercial/Multifamily
Baseline Condition	NC/RF/DI
Baseline	ISP/Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Normal Lighting Controls

Normal lighting controls include occupancy sensors, daylight dimmer systems, and occupancy controlled hi-low controls for fluorescent, LED and HID fixtures.

Networked Lighting Controls

This measure defines the savings associated with installing a network controlled lighting system. The control system must include luminaire-level lighting control (LLLC) that can switch lights on and off based on occupancy and is capable of full-range dimming based on local light levels. Note: Because networked lighting controls are required to include occupancy sensors and daylight harvesting, savings from occupancy sensors and daylight dimming control cannot be claimed separately. Additional savings may be achieved at no additional hardware cost on a site-specific basis by implementing high-end trimming, personalized local controls, and customized scheduling with no need for additional equipment or software.

Bi-level Lighting Controls

This measure addresses bi-level occupancy control of lighting in stairwells, corridors, parking garages and parking lots via the installation of controls on existing fixtures or installation of luminaires with integrated bi-level occupancy control. Bi-level occupancy control allows for the continuous lighting of spaces at code-mandated minimum illumination levels when the space is unoccupied and at higher light levels when occupied. This measure is only applicable as a retrofit or replacement in existing buildings because multi-level switching at defined lighting power densities and percentages of full connected load is mandated in many space types by federal, state, local and municipal codes and standards. This measure is restricted to lighting in parking lots and in spaces that are required by fire and safety code to be illuminated continuously. The post-implementation case must comply with all provisions of applicable fire, safety and construction code.

Baseline Case

Retrofit (RF): The baseline condition is the existing lighting system which includes controls such as continuous operation or manual on/off controls

New Construction (NC): The baseline condition a control system that meets ASHRAE 90.1-2019 or industry standard practice in new construction.

Efficient Case

Retrofit (RF): The efficient condition is the existing lighting system retrofitted with more efficient controls.

New Construction (NC): The efficient condition is the baseline system that meets ASHRAE 90.1-2019 or industry standard practice in new construction with additional controls.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Normal or Networked Lighting

$$\Delta kWh = kW_c \times Hrs \times (SVG_b - SVG_q) \times (1 + HVAC_e)$$

Bi-level Lighting

$$\Delta kWh = \left[\frac{W_b \times Qty_b}{1{,}000} - \left(\frac{W_q \times Qty_q}{1{,}000} \times (1 - SVG_{bl})\right)\right] \times Hrs$$

Where,

$$SVG_{bl} = F_{low} \times \left(1 - \frac{W_{low}}{W_q}\right)$$

Annual Fuel Savings

Normal or Networked Lighting

$$\Delta Therms = kW_c \times Hrs \times (SVG_b - SVG_q) \times HVAC_g \times 10$$

Bi-level Lighting

$$\Delta Therms = N/A$$

Peak Demand Savings

Normal or Networked Lighting

$$\Delta kW_{Peak} = kW_c \times (SVG_b - SVG_q) \times CF \times (1 + HVAC_d)$$

Bi-level Lighting

$$\Delta kW_{Peak} = \left[\frac{W_b \times Qty_b}{1{,}000} - \left(\frac{W_q \times Qty_q}{1{,}000} \times \left(1 - SVG_{bl,demand}\right)\right)\right] \times CF$$

Where,

$$SVG_{bl,demand} = F_{low} \times \left(1 - \frac{W_{low}}{W_q}\right)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-215 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ESF	Energy savings factor	Calculated	N/A	

Variable	Description	Value	Units	Ref
SVG_{bl}	Percent of annual lighting energy saved by the bilevel lighting control	Calculated	N/A	
$SVG_{bl,demand}$	Percent of annual lighting demand energy saved by the bilevel lighting control	Calculated	N/A	
kW_c	Lighting load connected to control	Site-specific	kW	
Qty_b	Quantity of existing fixture	Site-specific	N/A	
Qty_q	Quantity of efficient fixture	Site-specific	N/A	
W_b	Wattage of existing fixture	Site-specific	W	
W_q	Wattage of efficient fixture at full light output	Site-specific	W	
W_{low}	Wattage of the efficient fixture in low-power mode	Site-specific	Watts	
F_{low}	Percentage of annual operating hours that the fixture operated in low-power mode	Site-specific, if unknown lookup in Table 3-217	N/A	[567][568][569][570]
SVG_b	Percent of annual lighting energy saved by the baseline lighting control	Lookup in Table 3-216	N/A	[566]
SVG_q	Percent of annual lighting energy saved by the efficient lighting control	Lookup in Table 3-216	N/A	[566]
$HVAC_d$	Secondary demand in reduced HVAC consumption resulting from decreased indoor lighting wattage	Look up in Table 3-211 (in Section 3.7.1)	N/A	[564]
$HVAC_e$	Secondary energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage	Look up in Table 3-211 (in Section 3.7.1)	N/A	[564]
$HVAC_g$	Secondary energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage	Lookup in Appendix F: HVAC Interactivity Factors	MMBtu/kWh	[573]
Hrs	Annual hours of operation prior to installation of controls	Site-specific, if unknown use Table 3-210 (in Section 3.7.1)	Hours	[574]
ISR	In-service rate	Look up by program in Appendix J: In-Service Rates, or use default value = 1	N/A	
1,000	Conversion factor	1,000	kW/W	
10	Conversion factor	10	Therms/MMBtu	
CF	Electric coincidence factor	Lookup in Table 3-218	N/A	[574]

Variable	Description	Value	Units	Ref
PDF	Gas peak day factor	Lookup in Table 3-218	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-216 SVG

Lighting Control Type	SVG
Networked lighting controls (NLC)	0.49
Luminaire-level lighting controls (LLLC) – Networked & Commissioned	0.49
Integrated fixture with room-based controls	0.38[114]
Dual occupancy and daylight sensors	0.38
Combination of high-end trim and daylight dimming	0.35
Combination of high-end trim and occupancy sensors	0.33
Daylight dimming	0.28
Occupancy sensors	0.24
No lighting controls	0.00

Table 3-217 Low-Power Mode Factor

Space Type	F_{low}
Stairwell	0.73
Corridor	0.75
Parking Garage	0.56
Parking Lot	0.45

Peak Factors

Table 3-218 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Look up in Table 3-210 (in Section 3.7.1)	[571]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

[114] 38% is highest savings factor associated with a non-networked fixture with integrated controls. This was determined to be a reasonable assumption for a fixture with three integrated controls that is not networked or verified/commissioned.

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-219 Measure Life

Equipment	Measure Life	Ref
Lighting Controls	8	[572]

References

[564] Average HVAC interactive effects by building type derived from the NEEP Mid-Atlantic TRM 2017, NEEP, *Mid-Atlantic Technical Reference Manual*, V10, Appendix E.

[565] Massachusetts TRM, 2016-2018 Program Years, October 2015. Original source: DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory Council

[566] DNV. 2022. "X1931-4 ALC PSD Phase 2 Memo." Connecticut Energy Efficiency Board (EEB) and Evaluation Administrators.

[567] California Energy Commission, Lighting Research Program, Project 5.1 Bi-level Stairwell Fixture Performance Final Report, October 2005 – Average of "Time Dimmed" across the four test sites during weekday operation (Table 2. Weekday daily average energy usage and savings, pg. 22).

[568] CA State Partnership for Energy Efficiency Demonstrations, Interior Lighting Case Study: Adaptive Corridor Lighting, April 2014, pg. 2. https://cltc.ucdavis.edu/sites/default/files/files/publication/CASE_STUDY_UCSF_Adaptive_Corridors_140602.pdf

[569] California Energy Commission Public Interest Energy Research Program, Case Study: Bi-Level LED Parking Garage Luminaires – Average of unoccupied hours across the three test sites. https://cltc.ucdavis.edu/sites/default/files/files/publication/case-study-bi-level-led-garage-luminaires.pdf

[570] Pacific Gas & Electric, Application Assessment of Bi-Level LED Parking Lot Lighting, February 2009, pg. 1. https://www.osti.gov/biblio/1218189

[571] NEEP Mid-Atlantic TRM 2018, NEEP, Mid-Atlantic Technical Reference Manual, V8. May 2018, pp. 462-463.

[572] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

[573] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

[574] Navigant, *EmPOWER Maryland DRAFT Final Impact Evaluation Deemed Savings (June 1,2017 – May 31, 2018) Commercial & Industrial Prescriptive, Small Business, and Direct Install Programs*, (2018)

3.7.3 DELAMPING

Market	Commerical/Multifamily
Baseline Condition	ERET/DI
Baseline	Existing/Dual
End Use Subcategory	Lighting
Measure Last Reviewed	January 2023

Description

This measure relates to the permanent removal of a lamp and the associated electrical sockets (or "tombstones") from a fixture.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline conditions will vary dependent upon the characteristics of the existing fixture.

Efficient Case

The efficient condition will vary depending on the existing fixture and the number of lamps removed.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{Watts_b - Watts_q}{1{,}000} \times Hrs \times (1 + HVAC_e)$$

Annual Fuel Savings

$$\Delta Therms = \frac{Watts_b - Watts_q}{1{,}000} \times Hrs \times HVAC_g$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{Watts_b - Watts_q}{1{,}000} \times (1 + HVAC_d) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\, using\, existing\, baseline) \times RUL + (\Delta kWh\, using\, code\, baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\, using\, existing\, baseline) \times RUL + (\Delta Therms\, using\, code\, baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-220 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Watts_b$	Total Connected load of baseline fixture	Site-specific	Watts	
$Watts_q$	Total Connected load of delamped fixture	Site-specific	Watts	
Hrs	Deemed average hours of use per year	Look up in Table 3-210 (in Section 3.7.1)	Hrs/yr	[575]
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 3-211 (in Section 3.7.1)	N/A	[576][578]
$HVAC_g$	HVAC Interactive Factor for Annual Fuel Savings	Look up in Appendix F: HVAC Interactivity Factors	N/A	[580]
$HVAC_d$	HVAC Interactive Factor for Annual Demand Savings	Look up in Table 3-211 (in Section 3.7.1)	N/A	[576][578]

Variable	Description	Value	Units	Ref
CF	Electric coincidence factor	Look up in Table 3-210 (in Section 3.7.1)	N/A	[575]
PDF	Gas peak day factor	Look up in Table 3-222	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-221 HVAC Interactive Effects

Building Type	HVAC Interactive Factor for Peak Demand Savings ($HVAC_d$)		HVAC Interactive Factor for Annual Energy Savings ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/NonElec	AC/ElecRes	Heat Pump	NoAC/ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[115]	0.34	0.32	0.08	-0.18	-0.07	-0.26
Exterior	0.00	0.00	0.00	0.00	0.00	0.00

Peak Factors

Table 3-222 Peak Factors

Peak Factor	Value	Ref
Electric Coincedence (CF)	Look up in Table 3-210 (in Section 3.7.1)	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

[115] Per the NEEP Mid-Atlantic TRM, v7: “The ‘Other’ building type should be used when the building type is known but not explicitly listed above. A description of the actual building type should be recorded in the project documentation.”

Table 3-223 Measure Life

Equipment	EUL	RUL	Ref
Delamping	16	5.33	[577]

References

[575] Navigant, EmPOWER Maryland DRAFT Final Impact Evaluation Deemed Savings (June 1, 2017 – May 31, 2018) Commercial & Industrial Prescriptive, Small Business, and Direct Install Programs, (2018).

[576] Navigant, *EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs*, (2013)

[577] GDS Associates, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007 available at https://library.cee1.org/sites/default/files/library/8842/CEE_Eval_MeasureLifeStudyLights&HVACGDS_1Jun2007.pdf

[578] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*

[579] Northeast Energy Efficiency Partnerships & KEMA, *C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum.* (2011).

[580] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

3.7.4 EXIT SIGNS

Market	Commercial/Multifamily
Baseline Condition	EREP/DI
Baseline	Existing/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure relates to the installation of an exit sign illuminated with light emitting diodes (LED). This measure should be limited to early replacement applications. Note: While this measure is characterized as an early replacement, a dual baseline is not used as it is assumed that the existing fixture would have been maintained with new baseline lamps (and ballasts, if required) for the duration of the measure life.

Baseline Case

The baseline condition is an existing exit sign with a non-LED light-source.

Efficient Case

The efficient condition is a new exit sign illuminated with light emitting diodes (LED).

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{W_b - W_q}{1{,}000} \times Hrs \times (1 + HVAC_e)$$

Annual Fuel Savings

$$\Delta Therms = \frac{W_b - W_q}{1{,}000} \times Hrs \times HVAC_g$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{W_b - W_q}{1{,}000} \times (1 + HVAC_d) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-224 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
W_b	Actual Connected load of existing exit sign	Site-specific, if unknown look up in Table 3-225	kW	
W_q	Actual Connected load of LED exit sign	Site-specific, if unknown look up in Table 3-225	kW	
Hrs	Average hours of use per year	Site-specific, if unknown use 8,760	Hours	
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 3-226	N/A	[581][578]
$HVAC_g$	HVAC Interactive Factor for Annual Fuel Savings	Look up in Appendix F: HVAC Interactivity Factors	N/A	[587]
$HVAC_d$	HVAC Interactive Factor for Peak Demand Savings	Look up in Table 3-226	N/A	[581][578]

Variable	Description	Value	Units	Ref
CF	Electric coincidence factor	Look up in Table 3-227	N/A	
PDF	Gas peak day factor	Look up in Table 3-227	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-225 Connected Load by Bulb Type

Type	Single-Sided kW	Dual-Sided kW
Incandescent	0.020	0.040
Fluorescent	0.009	0.020
LED	0.002	0.004

Table 3-226 HVAC Interactivity Factors – Electric

Building Type	HVAC Interactive Factor for Peak Demand Savings ($HVAC_d$)		HVAC Interactive Factor for Annual Energy Savings ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/NonElec	AC/ElecRes	Heat Pump	NoAC/ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[116]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Peak Factors

Table 3-227 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.00	[583]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

[116] Per the NEEP Mid-Atlantic TRM, v7: "The 'Other' building type should be used when the building type is known but not explicitly listed above. A description of the actual building type should be recorded in the project documentation."

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-228 Measure Life

Equipment	EUL	RUL	Ref
Exit Signs	15	5	[584]

References

[581] EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs, Navigant, March 31, 2014. WHF values for Washington, D.C. and Delaware assume values from Maryland, Pepco and Maryland, DPL, respectively.

[582] Rundquist, R A, Johnson, K F, and Aumann, D J. 1993. 1993 ASHRAE Journal:"Calculating lighting and HVAC interactions". Typical aspect ratio for perimeter zones. Heating factor applies to perimeter zoneheat, therefore it must be adjusted to account for lighting in core zones.

[583] Efficiency Vermont Technical Reference Manual 2009-55, December 2008.

[584] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

[585] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*

[586] Northeast Energy Efficiency Partnerships & KEMA, *C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum.* (2011).

[587] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

3.7.5 LED SIGN LIGHTING

Market	Commercial/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Lighting
Measure Last Reviewed	January 2023

Description

This measure is applicable to the installation of LED sign lighting fixtures. This technology provides the required illumination at reduced input power. Typically, these signs are constructed from sheet metal sides forming the shape of letters and a translucent plastic lens. Luminance is most commonly provided by single or double strip neon lamps, powered by neon sign transformers. Retrofit kits are available to upgrade existing signage from neon to LED light sources, substantially reducing the electrical power and energy required for equivalent sign luminance. LED drivers can be either electronic switching or linear magnetic, with the electronic switching supplies being the most efficient. The on/off power switch may be found on either the power line or load side of the driver, with the line side location providing significantly lower standby losses when the sign is turned off and is not operating. All new open signs must meet UL-84 (UL-844) requirements. Replacement signs cannot use more than 20% of the input power of the sign that is being replaced.

Baseline Case

The baseline condition is fluorescent lighting or neon type illuminated LED open sign.

Efficient Case

The compliance condition is an LED type illuminated LED open sign.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{W_b - W_q}{1{,}000} \times Hrs \times (1 + HVAC_c)$$

Annual Fuel Savings

$$\Delta Therms = \frac{W_b - W_q}{1{,}000} \times Hrs \times HVAC_g$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{W_b - W_q}{1{,}000} \times (1 + HVAC_d) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-229 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
W_b	Equipment wattage for baseline condition	Site-specific, if unknown use 46	Watts	[588]
W_q	Equipment wattage for energy efficient condition	Site-specific	Watts	

Variable	Description	Value	Units	Ref
$HVAC_c$	HVAC interaction factor for annual electric energy consumption	0 for Exterior and Unconditioned Spaces; otherwise see Appendix F: HVAC Interactivity Factors	N/A	
$HVAC_d$	HVAC interaction factor at utility summer peak hour	0 for Exterior and Unconditioned Spaces; otherwise see Appendix F: HVAC Interactivity Factors	N/A	
$HVAC_g$	HVAC interaction factor for annual fuel consumption	0 for Exterior and Unconditioned Spaces; otherwise see Appendix F: HVAC Interactivity Factors	MMBtu/kWh	
Hrs	Annual hours of operation	Site-specific, If unknown use defaults: Signage with photocell control operate = 4,380 hours Signage with time switch control = 2,190 hours	Hrs	[594][595]
1,000	Conversion factor, one kilowatt equals 1,000 watts	1,000	N/A	
CF	Electric coincidence factor	Lookup in Table 3-43	N/A	[589][590][591][592][593]
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-230 CF by Building Type

Building Type	CF
Education	0.39
Exterior, Photocell-Controlled (All Building Types)	0.11
Exterior, All Other (All Building Types)	0.11
Grocery	0.99
Health	0.47
Industrial Manufacturing – 1 Shift	0.96
Industrial Manufacuring – 2 Shift	0.96
Industrial Manufacturing – 3 Shift	0.96
Institutional/Public Service	0.23
Lodging	0.38
Miscellaneous/Other	0.33

Building Type	CF
Multifamily Common Areas	0.73
Office	0.26
Parking Garages	0.98
Restaurant	0.55
Retail	0.56
Street Lighting	0.00
Warehouse	0.50
Outdoor	0.00

Peak Factors

Table 3-231 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Lookup in Table 3-43	[589][590][591][592][593]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-232 Measure Life

Equipment	EUL	RUL	Ref
LED Sign Lighting	15	5	[588]

References

[588] Measured average demand data. Southern California Edison, "Replace Neon Open Sign with LED Open Sign", Workpaper SCE13LG070, Revision 2, October 2015. Pg. 10.

[589] Illinois Statewide Technical Reference Manual for Energy Efficiency v7.0. Multifamily common area value based on DEER 2008. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/Final_9-28-18/IL-TRM_Effective_010119_v7.0_Vol_2_C_and_I_092818_Final.pdf Accessed December 2018.

[590] Pennsylvania Statewide Act 129 2014 Commercial & Residential Lighting Metering Study. Prepared for Pennsylvania Public Utilities Commission. January 13, 2015. http://www.puc.pa.gov/pcdocs/1340978.pdf

[591] U.S. Naval Observatory. Duration of Daylight/Darkness Table for One Year. https://aa.usno.navy.mil/data/docs/Dur_OneYear.php Assumes values for Philadelphia.

[592] Mid-Atlantic Technical Reference Manual v8.0, https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V7_FINAL.pdf

[593] UI and CL&P Program Savings Documentation for 2013 Program Year, United Illuminating Company, September 2012.

[594] ConEd Large C&I Program Impact and Process Evaluation Report prepared by Navigant, August 2019, slide 71.

[595] Time switch control – assume 6 hours per day, 365 days per year

3.7.6 INDOOR HORTICULTURE LED

Market	Commercial
Baseline Condition	NC/TOS/DI
Baseline	ISP/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

The method below is applicable to the installation of LED fixtures intended for indoor horticultural use that meet the DesignLights Consortium (DLC) Horticultural Lighting Technical Requirements Version 3.0 (Hort V3.0). This measure shall be used only for New Construction or fixture additions. Savings are based on the difference between the photosynthetic photon efficacies (PPE) of the efficient fixture and an industry standard practice fixture.

Baseline Case

The baseline fixtures meet the indoor agriculture industry standard practice photosynthetic photon efficacies (PPE) of 1.7 micromoles per Joule.

Efficient Case

The efficient case is the installation of new DLC qualified LED indoor agriculture fixtures having a PPE that meet is or exceeds the DLC Hort 3.0 standard of 2.3 micromoles per joule.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kW \times hrs \times (1 + HVAC_e)$$

Where,

$$\Delta kW = N_q \times W_q \times (\frac{PPE_q}{PPE_b} - 1)/1000$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kW \times CF \times (1 + HVAC_d)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-233 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔkW	Change in connected load from baseline to efficient lighting level	Calculated	kW	
Hrs	Annual hours of operation	Site-specific	hours	
N_q	Number of energy efficient fixtures	Site-specific	fixtures	
W_q	Wattage of energy efficient fixtures	Site-specific	W	
PPE_q	Photosynthetic photon efficacy (PPE) of qualifying equipment	Site-specific	μmol/j	
PPE_b	Photosynthetic photon efficacy (PPE) of baseline equipment	Lookup in Table 3-234	μmol/j	[597][598][599]
$HVAC_e$	HVAC interactive effects for electricity consumption	0.21	N/A	[599]
$HVAC_d$	HVAC interactive effects for electricity peak demand	0.22	N/A	[599]

Variable	Description	Value	Units	Ref
CF	Electric coincidence factor	Lookup in Table 3-235	N/A	
PDF	Gas peak demand factor	Lookup in Table 3-235	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-234 Baseline Photosynthetic Photon Efficacy (PPE)

Crop Type	Baseline Technology Type	Baseline PPE
Flowering Crops (Tomatoes and Peppers)	High Pressure Sodium	1.7
Vegetative Growth	Metal Halide	1.25
Microgreens	T5 HO Fixture	1.0
Propogation	T5 HO Fixture	1.0
Medical Cannabis – Flowering Stage	High Pressure Sodium	1.7
Medical Cannabis – Vegetative Stage	Metal Halide	1.25
Medical Cannabis – Cloning, Seeding, and Propogation	T5 HO Fixture	1.0
Recreational Cannabis – Flowering Stage	HID/LED/Other	2.2
Recreational Cannabis – Vegetative Stage	HID/LED/Other	2.2
Recreational Cannabis – Cloning, Seeding, and Propogation	T5/LED/Other	2.2

Peak Factors

Table 3-235 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	[600]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-236 Measure Life

Equipment	EUL	RUL	Ref
Indoor Horticulture LED	12	4	[601]

References

[596] Radetsky, Leora, “LED and HID Horticultural Luminaire Testing Report Prepared for Lighting Energy Alliance Members and Natural Resources Canada.” Rensselaer Polytechnic Institute, May 3, 2018; https://www.lrc.rpi.edu/programs/energy/pdf/HorticulturalLightingReport-Final.pdf

[597] Runkle, Erik and Bugbee, Bruce “Plant Lighting Efficiency and Efficacy; µmols per joule”, Greenhouse Product News: https://gpnmag.com/article/plant-lighting-efficiency-and-efficacy-%CE%BCmol%C2%B7j-%C2%B9/

[598] “LED Grow Light Buyer’s Guide.” 2016. Chilled Tech-LED Grow Lights & Spectrum Control. October 22, 2016. https://chilledgrowlights.com/education/led_buyers_guide

[599] *2022 Illinois Statewide Technical Reference Manual Version 10: Volume 2 Commercial and Industrial Measures*. (2022), Pg 38, https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf

[600] Indoor Horticulture Lighting Study, Sacramento Municipal Utility District, March 14, 2018; available at: https://www.smud.org/-/media/Documents/Business-Solutions-and-Rebates/Advanced-Tech-Solutions/LED-Reports/Amplified-Farms-Indoor-Horticulture-LED-Study-Final.ashx

[601] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

3.8 MOTORS AND DRIVES

3.8.1 MOTORS

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/Existing/Dual
End Use Subcategory	Motors
Measure Last Reviewed	January 2023

Description

This measure covers the installation of high efficiency, three-phase electric motors of 200 hp or less in commercial and industrial applications. Estimated energy savings are based on increased operating efficiency.

Efficient motors generally run at slightly higher RPM than standard motors. Unless the motor drive system is modified to correct for higher RPM operation, the power delivered by the motor may increase. This increase in power delivery may negate the effects of improved efficiency. Therefore, when replacing a standard-efficiency motor, a high-efficiency motor with lower or equal full-load speed must be selected to prevent any negation of predicted energy savings resulting from a higher efficiency. To provide the correct flow, it may be necessary to adjust fan sheaves or pump-impeller diameters.

Baseline Case

The baseline condition is a three-phase electric motor of equivalent type, speed and horsepower. For TOS, and NC, a minimally code compliant baseline should be applied. For EREP, the baseline will be of the existing equipment.

Efficient Case

The compliance condition is a three-phase electric HVAC fan or pump motor with a speed at or below that of the baseline motor and full-load efficiency exceeding the NEMA premium full-load efficiency.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = HP \times RLF \times 0.746 \times \left[\left(\frac{1}{Eff_b}\right) - \left(\frac{1}{Eff_q}\right)\right] \times FLH$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = HP \times RLF \times 0.746 \times \left[\left(\frac{1}{Eff_b}\right) - \left(\frac{1}{Eff_q}\right)\right] \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-237 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta kW_{Peak,}$	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
HP	Rated horsepower of the efficient equipment	Site-specific	HP	
Eff_q	Full-load efficiency of qualifying efficiency motor	Site-specific	N/A	
Eff_b	Full-load efficiency of code-compliant baseline motor	Site-specific or look up in Table 3-238 & Table 3-239	N/A	[602]
RLF	Ratio of the peak annual motor load to the maximum connected load	Site-specific, if unknown, use 0.75	N/A	[603]

Variable	Description	Value	Units	Ref
FLH	Full-load hours in the energy efficient case	Site-specific, if unknown look up in Table 3-240	Hrs	[604]
0.746	Unit conversion, kW/HP	0.746	kW/HP	
CF	Electric coincidence factor	Look up in Table 3-241	N/A	
PDF	Gas peak day factor	Look up in Table 3-241	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-238 Baseline Efficiencies for NEMA Design A and NEMA Design B Motors[117]

Motor HP	Motor Nominal Full-Load Efficiencies							
	2 Pole (3600 RPM)		4 pole (1800 RPM)		6 Pole (1200 RPM)		8 Pole (900 RPM)	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1	0.770	0.770	0.855	0.855	0.825	0.825	0.755	0.755
1.5	0.840	0.840	0.865	0.865	0.875	0.865	0.785	0.770
2	0.855	0.855	0.865	0.865	0.885	0.875	0.840	0.865
3	0.865	0.855	0.895	0.895	0.895	0.885	0.855	0.875
5	0.885	0.865	0.895	0.895	0.895	0.895	0.865	0.885
7.5	0.895	0.885	0.917	0.910	0.910	0.902	0.865	0.895
10	0.902	0.895	0.917	0.917	0.910	0.917	0.895	0.902
15	0.910	0.902	0.924	0.930	0.917	0.917	0.895	0.902
20	0.910	0.910	0.930	0.930	0.917	0.924	0.902	0.910
25	0.917	0.917	0.93.6	0.936	0.930	0.930	0.902	0.910
30	0.917	0.917	0.936	0.941	0.930	0.936	0.917	0.917
40	0.924	0.924	0.941	0.941	0.941	0.941	0.917	0.917
50	0.930	0.930	0.945	0.945	0.941	0.94.1	0.924	0.924
60	0.936	0.936	0.950	0.950	0.945	0.945	0.924	0.930

[117] Design indicates the torque/speed characteristics of the motor.
Design A: Maximum five percent slip, High to medium starting current, Normal locked rotor torque, Normal breakdown torque and Suited for a broad variety of applications, such as fans and pumps
Design B: Maximum five percent slip, Low starting current, High locked rotor torque, Normal starting torque, Normal breakdown torque and Suited for a broad variety of applications, such as fans and pumps - - common in HVAC application with fans, blowers and pumps

Motor HP	Motor Nominal Full-Load Efficiencies							
	2 Pole (3600 RPM)		4 pole (1800 RPM)		6 Pole (1200 RPM)		8 Pole (900 RPM)	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
75	0.936	0.936	0.954	0.950	0.945	0.945	0.936	0.941
100	0.941	0.936	0.954	0.954	0.950	0.950	0.936	0.941
125	0.950	0.941	0.954	0.954	0.950	0.950	0.941	0.941
150	0.950	0.941	0.958	0.958	0.958	0.954	0.941	0.941
200	0.954	0.950	0.962	0.958	0.958	0.954	0.945	0.941
250	0.958	0.950	0.962	0.958	0.958	0.958	0.950	0.950
300	0.958	0.954	0.962	0.958	0.958	0.958	N/A	N/A
350	0.958	0.954	0.962	0.958	0.958	0.958	N/A	N/A
400	0.958	0.958	0.962	0.958	N/A	N/A	N/A	N/A
450	0.958	0.962	0.962	0.962	N/A	N/A	N/A	N/A
500	0.958	0.962	0.962	0.962	N/A	N/A	N/A	N/A

Table 3-239 Baseline Motor Efficiencies for NEMA Design C Motors[118]

Motor HP	Motor Nominal Full-Load Efficiencies					
	4 Pole (1800 RPM)		6 Pole (1200 RPM)		8 Pole (900 RPM)	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1	0.855	0.855	0.825	0.825	0.755	0.755
1.5	0.865	0.865	0.875	0.865	0.785	0.770
2	0.865	0.865	0.885	0.875	0.840	0.865
3	0.895	0.895	0.895	0.885	0.855	0.875
5	0.895	0.895	0.895	0.895	0.865	0.885
7.5	0.917	0.910	0.910	0.902	0.865	0.895
10	0.917	0.917	0.910	0.917	0.895	0.902

[118] Design indicates the torque/speed characteristics of the motor.
Design C: Maximum five percent slip, Low starting current, High locked rotor torque, Normal breakdown torque and Suited for equipment with high inertia starts, such as positive displacement pumps

Motor HP	Motor Nominal Full-Load Efficiencies					
	4 Pole (1800 RPM)		6 Pole (1200 RPM)		8 Pole (900 RPM)	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
15	0.924	0.930	0.917	0.917	0.895	0.902
20	0.930	0.930	0.917	0.924	0.902	0.910
25	0.936	0.936	0.930	0.930	0.902	0.910
30	0.936	0.941	0.930	0.936	0.917	0.917
40	0.941	0.941	0.941	0.941	0.917	0.917
50	0.945	0.945	0.941	0.941	0.924	0.924
60	0.950	0.950	0.945	0.945	0.924	0.930
75	0.954	0.950	0.945	0.945	0.936	0.941
100	0.954	0.954	0.950	0.950	0.936	0.941
125	0.954	0.954	0.950	0.950	0.941	0.941
150	0.958	0.958	0.958	0.954	0.941	0.941
200	0.962	0.958	0.958	0.954	0.945	0.941

Table 3-240 Full-load Hours Based on Application and Building Type

Facility Type	Distribution Fan Motor	CHWP & Cooling Towers	Heating Pumps
Auto Related	4,056	1,878	5,376
Bakery	2,854	1,445	5,376
Banks, Financial Centers	3,748	1,767	5,376
Church	1,955	1,121	5,376
College - Cafeteria	6,376	2,713	5,376
College - Classes/Administrative	2,586	1,348	5,376
College - Dormitory	3,066	1,521	5,376
Commercial Condos	4,055	1,877	5,376
Convenience Stores	6,376	2,713	5,376
Convention Center	1,954	1,121	5,376
Court House	3,748	1,767	5,376
Dining: Bar Lounge/Leisure	4,182	1,923	5,376

Facility Type	Distribution Fan Motor	CHWP & Cooling Towers	Heating Pumps
Dining: Cafeteria / Fast Food	6,456	2,742	5,376
Dining: Family	4,182	1,923	5,376
Entertainment	1,952	1,120	5,376
Exercise Center	5,836	2,518	5,376
Fast Food Restaurants	6,376	2,713	5,376
Fire Station (Unmanned)	1,953	1,121	5,376
Food Stores	4,055	1,877	5,376
Gymnasium	2,586	1,348	5,376
Hospitals	7,674	3,180	5,376
Hospitals / Health Care	7,666	3,177	5,376
Industrial - 1 Shift	2,857	1,446	5,376
Industrial - 2 Shift	4,730	2,120	5,376
Industrial - 3 Shift	6,631	2,805	5,376
Laundromats	4,056	1,878	5,376
Library	3,748	1,767	5,376
Light Manufacturers	2,857	1,446	5,376
Lodging (Hotels/Motels)	3,064	1,521	5,376
Mall Concourse	4,833	2,157	5,376
Manufacturing Facility	2,857	1,446	5,376
Medical Offices	3,748	1,767	5,376
Motion Picture Theatre	1,954	1,121	5,376
Multifamily (Common Areas)	7,665	3,177	5,376
Museum	3,748	1,767	5,376
Nursing Homes	5,840	2,520	5,376
Office (General Office Types)	3,748	1,767	5,376
Office/Retail	3,748	1,767	5,376
Parking Garages & Lots	4,368	1,990	5,376
Penitentiary	5,477	2,389	5,376
Performing Arts Theatre	2,586	1,348	5,376
Police / Fire Stations (24 Hr)	7,665	3,177	5,376
Post Office	3,748	1,767	5,376

Facility Type	Distribution Fan Motor	CHWP & Cooling Towers	Heating Pumps
Pump Stations	1,949	1,119	5,376
Refrigerated Warehouse	2,602	1,354	5,376
Religious Building	1,955	1,121	5,376
Residential (Except Nursing Homes)	3,066	1,521	5,376
Restaurants	4,182	1,923	5,376
Retail	4,057	1,878	5,376
School / University	2,187	1,205	5,376
Small Services	3,750	1,768	5,376
Sports Arena	1,954	1,121	5,376
Town Hall	3,748	1,767	5,376
Transportation	6,456	2,742	5,376
Warehouse (Not Refrigerated)	2,602	1,354	5,376
Waste Water Treatment Plant	6,631	2,805	5,376
Workshop	3,750	1,768	5,376

Peak Factors

Table 3-241 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[386]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-242 Measure Life

Equipment	EUL	RUL	Ref
Motors	15	5	[606]

References

[602] Energy Conservation Program: Energy Conservation Standards for Commercial and Industrial Electric Motors; Final Rule," 79 Federal Register 103, May 2014. https://www.gpo.gov/fdsys/pkg/FR-2014-05-29/html/2014-11201.htm

[603] U.S. DOE, Determining Electric Motor Load and Efficiency, April 2014, https://energy.gov/sites/prod/files/2014/04/f15/10097517.pdf

[604] Connecticut Program Savings Document, 12th Edition for 2017 Program Year, UIL Holdings Corporation and Eversource Energy Appendix 5, Hours of Use, October 2016.

[605] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 9, January 2022. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf.

[606] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.8.2 VFD

Market	Commercial/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure defines savings associated with installing a variable frequency drive on a motor of 200 hp or less for the following HVAC applications: supply air fans, return air fans, chilled water and condenser water pumps, hot water circulation pumps, water source heat pump circulation pumps, cooling tower fans, and boiler feed water pumps. VFD applications for other end uses are not covered under this measure.

Baseline Case

The baseline condition is a motor, 200 hp or less, without a VFD control.

Efficient Case

The efficient condition is a motor, 200 hp or less, with a VFD control.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = 0.746 \times HP \times \frac{LF}{\eta_{motor}} \times hr \times ESF$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = 0.746 \times HP \times \frac{LF}{\eta_{motor}} \times \mathrm{DSF}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \mathrm{N/A}$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-243 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
HP	Rated horsepower of the motor	Site-specific	HP	
hr	Annual run hours of the baseline motor	Lookup in Appendix D: HVAC Fan and Pump Operating Hours	hours	
LF	Load Factor	Site-specific, if unknown use fans: 0.76, pumps: 0.79	N/A	[607]
η_{motor}	Motor efficiency at the full-rated load.	Site-specific	N/A	
ESF	Energy Savings Factor	Lookup in Table 3-244	Fraction	[608]
DSF	Demand Savings Factor	Lookup in Table 3-244	Fraction	[608]
0.746	Conversion factor for HP to kW	0.746	kW/HP	
CF	Electric coincidence factor	Look up in Table 3-245	N/A	
PDF	Gas peak demand factor	Look up in Table 3-245	N/A	

Variable	Description	Value	Units	Ref
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-244 Energy and Demand Savings Factors

Equipment Type	Baseline Control Type	ESF	DSF
HVAC Fan	Constant Volume	0.500	0.200
	Two-Speed	0.450	0.200
	Air Foil/Backward Incline	0.396	0.220
	Air Foil/Backward Incline with Inlet Guide Vanes	0.210	0.050
	Forward Curved	0.191	0.110
	Forward Curved with Inlet Guide Vanes	0.055	0.010
HVAC Pump	Constant Volume	0.661	0.210
	Throttle Valve	0.523	0.180

Peak Factors

Table 3-245 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

This is a retrofit measure being applied to existing operational equipment (motor). Hence, the effective useful life (EUL) is the smaller of the host equipment remaining life or the full measure life of the upgrade which is 5 years [670].

References

[607] Regional Technical Forum. Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors. November 5, 2012. Appendix C, Table 6.

[608] 2019 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 7.0. Volume 2: Commercial and Industrial Measures. September 28, 2018. https://www.ilsag.info/il_trm_version_7/

[609] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.8.3 ELEVATOR MODERNIZATION

Market	Commercial/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Controls
Measure Last Reviewed	May 2023

Description

This measure covers the upgrade of existing elevators by replacing critical components in order for elevators to be able to handle new technology, have better performance, and to operate more efficiently. This measure follows the New York TRM v10 [516].

Elevator modernization typically includes motor upgrades, elevator drive system upgrades, and elevator controller replacement. This measure covers the installation of SiliconControlled Rectifier (SCR) drives, Pulse Width Modulation (PWM) drives, and Variable Voltage Variable Frequency (VVVF) drives only. Only the following upgrade configurations are applicable to this measure: VVVF drive systems replace PWM systems, VVVF or PWM drive systems replace SCR systems, and VVVF, PWM, or SCR drive systems replace Motor-Generator (M-G) set systems. The drives may either be regenerative or non-regenerative. This measure is only applicable as a retrofit and only applies to office and multifamily buildings (e.g. small office, large office, low-rise multifamily, high-rise multifamily). This measure does not cover Destination Dispatch optimization technique.

Methods for calculating savings for M-G set baseline systems are presented below separate from SCR or PWM drive baseline systems in order to differentiate the baseline efficiency term as described in the Baseline Efficiency section below, but also to account for AC motor idling energy consumption present in an M-G set drive. There is no idling motor present in PWM or SCR drive systems, and thus no savings associated with idle energy is claimed in those cases.

Baseline Case

The baseline case is an existing M-G set, SCR drive, or PWM drive elevator system.

Efficient Case

The efficient case may be either Silicon-Controlled Rectifier (SCR) drive, Pulse Width Modulation (PWM) drive or ***v***ariable Voltage Variable Frequency (VVVF) based on the baseline condition, as outlined in the table below:

Baseline Case	Efficient Case
M-G set	SCR, PWM, VVVF drives
SCR drive	PWM, VVVF drives
PWM drive	VVVF drive

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Motor-Generator set (M-G) baseline:

$$\Delta kWh = kWh_b - kWh_q + (RegenSF \times \Delta kWh_{regen})$$

$$kWh_b = \left(\frac{\mathrm{lb_b} \times (1 - OCW_b) \times (ft/min)_b}{33{,}000 \times Eff_{hoist}} \times \frac{1}{Eff_b} \times 0.746 \times LF_{avg} \times hrs\right) + \left(\frac{hp \times 0.746 \times LF_{motor,idle}}{Eff_b} \times (8{,}760 - hrs) \times F_{idle}\right)$$

$$kWh_q = \frac{lb_q \times (1 - OCW_q) \times (ft/min)_q}{33{,}000 \times Eff_{hoist}} \times \frac{1}{Eff_q} \times 0.746 \times LF_{avg} \times hrs$$

$$\Delta kWh_{regen} = \frac{lb_q \times (1 - OCW_q) \times (ft/min)_q \times Eff_q \times 0.746}{33{,}000} \times Eff_{regen} \times F_{regen} \times hrs$$

$$Eff_b = Eff_{motor,b} \times Eff_{gear,b} \times Eff_{drive,b}$$

$$Eff_q = Eff_{motor,q} \times Eff_{gear,q} \times Eff_{drive,q}$$

SCR drive or PWM drive baseline:

$$\Delta kWh = kWh_b - kWh_q + (RegenSF \times \Delta kWh_{regen})$$

$$kWh_b = \left(\frac{\mathrm{lb_b} \times (1 - OCW_b) \times (ft/min)_b}{33{,}000 \times Eff_{hoist}} \times \frac{1}{Eff_b} \times 0.746 \times LF_{avg} \times hrs\right)$$

$$kWh_q = \frac{lb_q \times (1 - OCW_q) \times (ft/min)_q}{33{,}000 \times Eff_{hoist}} \times \frac{1}{Eff_q} \times 0.746 \times LF_{avg} \times hrs$$

$$\Delta kWh_{regen} = \frac{lb_q \times (1 - OCW_q) \times (ft/min)_q \times Eff_q \times 0.746}{33{,}000} \times Eff_{regen} \times F_{regen} \times hrs$$

$$Eff_b = Eff_{motor,b} \times Eff_{gear,b} \times Eff_{drive,b}$$

$$Eff_q = Eff_{motor,q} \times Eff_{gear,q} \times Eff_{drive,q}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Annual Peak Demand Savings

Motor-Generator set (M-G) baseline:

$$\Delta kW_{Peak} = \frac{hp \times 0.746 \times LF_{motor,run}}{Eff_b} - \frac{lb_q \times \left(1 - OCW_q\right) \times (ft/\min)_q \times 0.746 \times LF_{peak}}{33{,}000 \times Eff_{hoist} \times Eff_q}$$

SCR drive or PWM drive baseline:

$$\Delta kW_{Peak} = \left(\frac{lb_b \times (1 - OCW_b) \times (ft/\min)_b}{Eff_b} - \frac{lb_q \times \left(1 - OCW_q\right) \times (ft/\min)_q}{Eff_q}\right) \times \frac{LF_{peak} \times 0.746}{33{,}000 \times Eff_{hoist}}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-246 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual fuel savings	Calculated	Therms/yr	
ΔkWh_{Peak}	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime fuel savings	Calculated	Therms	
kWh_b	Energy consumption of baseline	Calculated	kWh	
kWh_q	Energy consumption of qualifying	Calculated	kWh	
ΔkWh_{regen}	Energy savings due to regenerative braking system	Calculated	kWh	
Eff_b	Energy efficiency, baseline	Calculated	N/A	
Eff_q	Energy efficiency, qualifying	Calculated	N/A	
lb_b	Capacity of car, baseline	Site-specific	Lbs	
OCW_b	Overweight of counterbalance as fraction of car capacity, baseline	Site-specific	N/A	

Variable	Description	Value	Units	Ref
$(ft/min)_b$	Rated top velocity of car, baseline	Site-specific	Ft/min	
Hp	Horsepower of M-G set motor	Site-specific	Hp	
OCW_q	Overweight of counterbalance as fraction of car capacity, qualifying	Site-specific	N/A	
$(ft/min)_q$	Rated top velocity of car, qualifying	Site-specific	Ft/min	
$Eff_{motor,b}$	NEMA premium efficiency, baseline	Site-specific	N/A	
$Eff_{motor,q}$	NEMA premium efficiency, qualifying	Site-specific	N/A	
Hrs	Annual hours of elevator operation	Site-specific, if unknown use 2,2750	Hours	[611]
$Eff_{drive,b}$	Efficiency of drive, baseline	Site-specific, if unknown use defaults: SCR6 = 0.85 SCR12 = 0.90 PWM = 0.94	N/A	[612]
$Eff_{drive,q}$	Efficiency of drive, qualifying	Site-specific, if unknown use defaults: SCR6 = 0.85 SCR12 = 0.90 PWM = 0.94 VVF = 0.95	N/A	[612]
$Eff_{gear,b}$	Efficiency of gear system, baseline	Geared system: 0.85 Gearless system: 1.0	N/A	[612]
$Eff_{gear,q}$	Efficiency of gear system, qualifying	Geared system: 0.85 Gearless system: 1.0	N/A	[612]
RegenSF	Savings factor for regererative braking system	Regenerative braking: 1 No regenerative breaking: 0	N/A	[516]
LF_{avg}	Average load factor	0.35	N/A	[613]
Eff_{hoist}	Efficiency of elevator hoise system	0.9	N/A	[611]
$LF_{motor,idle}$	M-G set motor load factor in idling mode	0.11	N/A	[516]
F_{idle}	Idling factor; used to account for fraction of run hours M-G set system in idling mode	Timer incorporated: 0.7 No timer: 1.0 Unknown: 0.7	N/A	[614]
Eff_{regen}	Efficiency of regenerative braking system	0.5	N/A	[516]
F_{regen}	Regenerative breaking factor; used account for fraction of run hours regenerative braking produces energy savings	0.5	N/A	[615]
8,760	Hours in a year	8,760	Hours	
33,000	Conversion factor	33,000	(ft-lb/min)/hp	

Variable	Description	Value	Units	Ref
0.746	Conversion factor	0.746	kW/hp	
EUL	Effective useful life	See Measure Life section	Years	

Peak Factors

Table 3-247 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A: Appling average load factor at peak is a conservative approach for estimating summer peak demand savings. No further adjustment is required.	[516]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 15 years [616].

References

[610] New York TRM v10, Elevator Modernization, pg. 887. https://dps.ny.gov/technical-resource-manual-trm

[611] The Vertical Transportation Handbook, 4th Edition , by George R. Strakosch and Robert S. Caporale, Table 4.2, Table 4.3, Chart 4.2.

[612] International Association of Elevator Consultants, Presentation in New York City, May 2011, Slide 11.

[613] ISO 25745-2:2015: Energy Performance of Lifts, Escalators and Moving Walks -- Part 2: Energy Calculation and Classification for Lifts (elevators).

[614] Actual idling time is based on specific site operating conditions. A value of 70% has been assumed based on a reasonable and conservative approach.

[615] Baldor Motors and Drives, Elevator Application Guide, pg. 3-6.

[616] Assumes same EUL as VFD measure, source DEER 2014.

3.9 PLUG LOAD

3.9.1 NETWORK POWER MANAGEMENT

Market	Commercial
Baseline Condition	RF
Baseline	ISP
End Use Subcategory	Office Equipment
Measure Last Reviewed	December 2022

Description

This measure covers savings achieved by controlling the power management settings of desktop computers, monitors, and laptops through centralized computer power management software that is installed on a network of computers to monitor and record the usage and manage the power settings of all units. This software is implemented at the network level and manipulates the internal power settings of the central processing unit (CPU) and monitor.

Eligible software should be capable of the following:

- Apply specific power management policies to network groups and monitor workstation keyboard, mouse, CPU and disk activity in determining workstation idleness.
- Allow centralized control and override of computer power management settings of workstations which include both a computer monitor and CPU (i.e. a desktop or laptop computer on a distributed network).
- Wake-on-LAN capability to allow networked workstations to be remotely wakened from or placed into any power-saving mode and to remotely boot or shut down ACPI-compliant workstations.
- Software should be compatible with multiple operating systems and hardware configurations on the same network.
- Have capability to produce system reports to confirm the inventory and performance of equipment on which the software is installed.

Baseline Case

Desktop computer, monitor, or laptop in which power management settings are not controlled by centralized power management software.

Efficient Case

Qualifying software which controls computer and monitor power settings from a central location.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = ESAV \times units$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = DSAV \times units$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \mathrm{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \mathrm{N/A}$$

Calculation Parameters

Table 3-248 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	[617]
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ESAV	Energy Savings per unit	Look up in Table 3-249	kWh/unit	
DSAV	Peak Demand Savings per unit	Look up in Table 3-249	kW/unit	
units	Number of units	Site-specific	units	
CF	Electric coincidence factor	See Peak Factors section	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[618]

To determine savings, the per unit estimate in Table 3-249 will be multiplied by the number of units. The energy savings per unit includes power savings from the PC as well as the monitor. Default savings are based on the Low Carbon IT

Savings Calculator sourced from the ENERGY STAR website [617] and assumes the absence of an enabled network power management as the baseline condition.

Table 3-249 Network Power Controls, Per Unit Summary Table

Measure	Unit	Energy Savings ($ESAV$)	Peak Demand Savings ($DSAV$)
Network PC Plug Load Power Management Software	Workstation – Desktop Computer with Monitor	392	0.0527
Network PC Plug Load Power Management Software	Workstation – Laptop Computer with Monitor[119]	237	0.0319

Peak Factors

Peak savings are incorporated in the demand savings values above.

Measure Life

The effective useful life (EUL) is 5 years [618].

References

[617] ENERGYSTAR Low Carbon IT Savings Calculator: https://www.energystar.gov/sites/default/files/asset/document/LowCarbonITSavingsCalc.xlsx

[618] Computers and peripheral equipment are considered 5-year property. 2016 IRS Publication 946. https://www.irs.gov/pub/irs-prior/p946--2016.pdf.

[119] Savings assume workstation includes desktop with monitor and laptop computer with laptop screen in use. Please refer to ENERGY STAR Low Carbon IT Savings Calculator for different workstation configurations [617].

3.9.2 OFFICE EQUIPMENT

Market	Commercial/Multifamily
Baseline Condition	TOS
Baseline	ISP
End Use Subcategory	Electronics
Measure Last Reviewed	December 2022

Description

This section provides deemed savings for installing ENERGYSTAR office equipment compliant with Energy Star Computer Specification ver. 8.0 compared to standard efficiency equipment in commercial applications. Per unit savings are primarily derived from the ENERGY STAR calculator for office equipment [619].

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline condition is assumed to be standard equipment of similar type used in a commercial setting.

Efficient Case

The efficient condition is ENERGY STAR equipment meeting the current ENERGY STAR ver. 8.0 Eligibility Criteria [620] and used in a commercial setting.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = ESF \times (1 + HVAC_e)$$

Annual Fuel Savings

$$\Delta Therms = ESF \times HVAC_g$$

Peak Demand Savings

$$\Delta kW_{Peak} = DSF \times (1 + HVAC_d)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-250 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ESF	Energy savings factor	Look up in Table 3-251	kWh/yr	[619]
DSF	Electric Demand savings factor	Look up in Table 3-251	kW	[619]
$HVAC_e$	HVAC Interactive Factor for Annual Energy Savings	Look up in Table 3-252	N/A	[621][622]
$HVAC_d$	HVAC Interactive Factor for Peak Demand Savings	Look up in Table 3-252	N/A	[621][622]
$HVAC_g$	HVAC Interactive Factor for Annual Fuel Savings	Look up in Appendix F: HVAC Interactivity Factors	N/A	[623]
ΔkW_{Peak}	Peak Demand Savings	Look up in Table 3-251	kW	[619]
CF	Electric coincidence factor	Look up in Table 3-253	N/A	
PDF	Natural gas peak day factor (PDF)	Look up in Table 3-253	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	

Table 3-251 Office Equipment Energy and Demand Savings Factors per Unit

Measure	ESF (kWh)	DSF (kW)	Source
Computer (Desktop)	124	0.0161	[619]
Computer (Laptop)	37	0.0030	[619]
Fax Machine (laser)	16	0.0022	[619]

Measure		ESF (kWh)	DSF (kW)	Source
Copier (monochrome)	≤ 5images/min	37	0.0050	[619]
	5 < images/min ≤ 15	26	0.0035	
	15 < images/min ≤ 20	10	0.0011	
	20 < images/min ≤ 30	42	0.0057	
	30 < images/min ≤ 40	50	0.0068	
	40 < images/min ≤ 65	181	0.0244	
	65 < images/min ≤ 82	372	0.0502	
	82 < images/min ≤ 90	469	0.0633	
	> 90 images/min	686	0.0926	
Printer (laser, monochrome)	≤ 5 images/min	37	0.0050	[619]
	5 < images/min ≤ 15	26	0.0035	
	15 < images/min ≤ 20	24	0.0031	
	20 < images/min ≤ 30	42	0.0057	
	30 < images/min ≤ 40	50	0.0068	
	40 < images/min ≤ 65	181	0.0244	
	65 < images/min ≤ 82	372	0.0502	
	82 < images/min ≤ 90	542	0.0732	
	> 90 images/min	686	0.0926	
Printer (Ink Jet)		6	0.0008	[619]
Multifunction Device (laser, monochrome)	≤ 5 images/min	57	0.0077	[619]
	5 < images/min ≤ 10	48	0.0065	
	10 < images/min ≤ 26	52	0.0070	
	26 < images/min ≤ 30	93	0.0126	
	30 < images/min ≤ 50	248	0.0335	
	50 < images/min ≤ 68	420	0.0567	
	68 < images/min ≤ 80	597	0.0806	
	> 80 images/min	764	0.1031	
Multifunction Device (Ink Jet)		6	0.0008	[619]
Monitor		8	0.0032	[619]

Table 3-252 HVAC Interactive Effects

Building Type	HVAC Interactive Factor for Peak Demand Savings (HVACd)		HVAC Interactive Factor for Annual Energy Savings (HVACe)			
	AC (Utility)	AC (PJM)	AC/NonElec	AC/ElecRes	Heat Pump	NoAC/ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[120]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Peak Factors

Table 3-253 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Peak savings incorporated in the DSF Values found in Table 1-2 above	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

Table 3-254 Measure Life [619]

Equipment	Measure Life
Computer	4 years
Monitor	4 years
Fax	4 years
Printer	5 years
Copier	6 years
Multifunction Device	6 years

References

[619] ENERGY STAR Office Equipment Calculator. https://dnr.mo.gov/sites/dnr/files/media/file/2021/01/office-equipment-calculator.xlsx. Default values were used. Using a commercial office equipment load shape, the percentage of total savings that occur during the PJM

[120] Per the NEEP Mid-Atlantic TRM, v7: "The 'Other' building type should be used when the building type is known but not explicitly listed above. A description of the actual building type should be recorded in the project documentation."

peak demand period was calculated and multiplied by the energy savings. As of December 1, 2018, the published ENERGY STAR Office Equipment Calculator does not reflect the current specification for computers (ENERGY STAR® Program Requirements Product Specification for Computers Eligibility Criteria Version 8.0). As a result, the savings values for computers presented in this measure entry reflect savings for V6-compliant models. This characterization should be updated when an updated ENERGY STAR Office Equipment Calculator becomes available.

[620] ENERGY STAR Product Specifications & Partner Commitments Search, https://www.energystar.gov/products/spec

[621] Navigant, EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs, (2013)

[622] DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory

[623] Northeast Energy Efficiency Partnerships & KEMA, C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum. (2011).

3.9.3 SMART STRIP

Market	Commercial/Multifamily
Baseline Type	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	December 2022

Description

This measure covers the installation of Tier 1 Advanced Power Strips (APS) in office workstations. The Tier 1 APS makes use of a control outlet to disconnect the controlled plugs when the load on the control outlet (usually a computer) is reduced below a threshold. In this case, the reduction below threshold of the control plug happens when the computer shuts down or enters standby mode. Therefore, the overall load of a centralized group of equipment (e.g., monitors and other peripherals for the computer) can be reduced. This measure assumes an office operating schedule of 7:30 AM to 5:30 PM from Monday to Fridays.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline condition is an office workstation with no plug load control system.

Efficient Case

The compliance condition is an office workstation with a tier 1 plug load control advanced power strip.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \left(\Delta kW_{wkday} \times \left(Hrs_{wkday} - Hrs_{wkday-open}\right) + \Delta kW_{wkend} \times \left(Hrs_{wkend} - Hrs_{wkend-open}\right)\right) \times Wks$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = 0$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \mathrm{N/A}$$

Calculation Parameters

Table 3-255 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	0	kW	[626]
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Units	Number of measures installed under the program	Site-specific	N/A	
ΔkW_{wkday}	Average power reduction during weekday off hours	0.0315	kW	[625][626]
Hrs_{wkday}	Total hours during the work week (Monday 7:30 AM to Friday 5:30 PM)	106	Hrs	
$Hrs_{wkday\text{-}open}$	Hours the office is open during the work week	Site-specific. If unknown, assume 50	Hrs	
ΔkW_{wkend}	Average power reduction during weekend off hours	0.0067	kW	[625][626]
Hrs_{wkend}	Total hours during the weekend (Friday 5:30 PM to Monday 7:30 AM)	62	Hrs	
$Hrs_{wkend\text{-}open}$	Hours the office is open during the weekend	Site-specific, if unknown use 0	Hrs	
Wks	Weeks the office is open during the year	Site-specific, if unknown use 8760/168	Weeks/yr	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 3-256 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The expected lifetime of this measure is 4 years [625].

References

[624] Sheppy, M, I Metzger, D Cutler, G Holland, and A Hanada. 2014. “Reducing Plug Loads in Office Spaces Hawaii and Guam Energy Improvement Technology Demonstration Project.” https://www.nrel.gov/docs/fy14osti/60382.pdf.

[625] David Rogers, Power Smart Engineering, "Smart Strip Electrical Savings and Usability," October 2008.

[626] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Pg 494. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

3.9.4 UNINTERRUPTIBLE POWER SUPPLY

Market	Commercial
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Plug Load
Measure Last Reviewed	January 2023

Description

This measure is for replacing an inefficient uninterruptable power supply (UPS) with an efficient ENERGY STAR rated UPS within the scope of the Energy Star Uninterruptable Power Supply ver 2.0 Program Requirements. UPS units provide backup power in data centers and draw power constantly to keep their batteries charged. UPSs are utilized in many organizations to protect themselves from downtime with power distribution and avoid data processing errors due to downtimes. UPS systems are connected between the public power distribution system and mission critical loads.

This measure was developed to be applicable to the following program types: TOS. If applied to other program types, the measure savings should be verified through a custom calculation.

Baseline Case

The baseline condition is a non-ENERGY STAR UPS in a telecommunication or similar application meeting minimum Federal Efficiency Standards as defined in 10 CFR 430.32(z)(3)

Efficient Case

The efficient condition is a new UPS meeting ENERGY STAR UPS in a telecommunication or similar application meeting Energy Star UPS version 2.0 criteria. For single-normal mode UPSs, the installed system must meet or exceed the average loading-adjusted efficiency values required by the ENERGY STAR program.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = Size \times \left(\frac{1}{Eff_{AVGBase}} - \frac{1}{Eff_{AVGee}}\right) \times EFLH$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = Size \times \left(\frac{1}{Eff_{AVGBase}} - \frac{1}{Eff_{AVGee}}\right) \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-257 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
Size	Size of UPS in rated output power, kW	Site-specific	kW	
$Eff_{AVGbase}$	Efficiency of existing UPS	**Site-specific, if unknown look up in** Table 3-258	W	[627]
Eff_{AVGee}	Efficiency of new ENERGY STAR UPS	Site-specific, if unknown look up in Table 3-259	W or kW	[628]
E_{MOD}	An allowance of 0.004 for Modular UPSs applicable in the commercial 1500 – 10,000 W range	0.004	N/A	[628]
EFLH	Equivalent Full Load Hours	Look up in Table 3-260	hours	[629]
CF	Electric coincidence factor	Look up in Table 3-261	N/A	
PDF	Gas peak day factor	Look up in Table 3-261	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[630]

Table 3-258 Efficiency of existing UPS

UPS Product Class	Rated Output Power (P) in watts	Minimum Efficiency
Voltage and Frequency Dependent (VFD)	P ≤ 300 W	$-1.20 \times 10^{-6} \times P^2 + 7.17 \times 10^{-4} \times P + 0.862$
	300 W < P ≤ 700 W	$-7.85 \times 10^{-8} \times P^2 + 1.01 \times 10^{-4} \times P + 0.946$
	P > 700 W	$-7.23 \times 10^{-9} \times P^2 + 7.52 \times 10^{-6} \times P + 0.977$
Voltage Independent (VI)	P ≤ 300 W	$-1.20 \times 10^{-6} \times P^2 + 7.19 \times 10^{-4} \times P + 0.863$
	300 W < P ≤ 700 W	$-7.67 \times 10^{-8} \times P^2 + 1.05 \times 10^{-4} \times P + 0.947$
	P > 700 W	$-4.62 \times 10^{-9} \times P^2 + 8.54 \times 10^{-6} \times P + 0.979$
Voltage and Frequency Independent (VFI)	P ≤ 300 W	$-3.13 \times 10^{-6} \times P^2 + 1.96 \times 10^{-3} \times P + 0.543$
	300 W < P ≤ 700 W	$-2.60 \times 10^{-7} \times P^2 + 3.65 \times 10^{-4} \times P + 0.764$
	P > 700 W	$-1.70 \times 10^{-8} \times P^2 + 3.85 \times 10^{-5} \times P + 0.876$

Table 3-259 Efficiency of ENERGY STAR UPS Version 2.0

UPS Product Class	Rated Output Power (P) in watts	Minimum Efficiency
Voltage and Frequency Dependent (VFD)	P ≤ 350 W	$5.71 \times 10^{-5} \times P + 0.962$
	350 W < P ≤ 1.5 kW	0.982
	1.5 W < P ≤ 10 kW	$0.981 - E_{MOD}$
	P > 10 kW	0.97
Voltage Independent (VI)	P ≤ 350 W	$5.71 \times 10^{-5} \times P + 0.964$
	350 W < P ≤ 1.5 kW	0.984
	1.5 kW < P ≤ 10 kW	$0.980 - E_{MOD}$
	P > 10 kW	0.940
Voltage and Frequency Independent (VFI)	P ≤ 350 W	$0.011 \times \ln(P) + 0.824$
	350 W < P ≤ 1.5 kW	$0.011 \times \ln(P) + 0.824$
	1.5 W < P ≤ 10 kW	$0.0145 \times \ln(P) + 0.8 - E_{MOD}$
	P > 10 kW	$0.0058 \times \ln(P) + 0.886$

Table 3-260 Equivalent Full Load Hours

Rated Output Power (P) in Watts	UPS Product Class	Time spent at specified proportion of reference test load (t)				EFLH[121]
		25%	50%	75%	100%	
P ≤ 1.5 kW	VFD	0.2	0.2	0.3	0.3	5913
	VI or VFI	0	0.3	0.4	0.3	6570
1.5 kW < P ≤ 10 kW	VFD, VI, or VFI	0	0.3	0.4	0.3	6570
P > 10 kW	VFD, VI, or VFI	0.25	0.5	0.25	0	4380

Peak Factors

Table 3-261 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 10 years [630].

References

[627] Code of Federal Regulations, Energy Conservation Standards for Uninterruptible Power Supplies, effective January 10, 2022 (10 CFR 430.32(z)(3). https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[628] ENERGY STAR Uninterruptible Power Supplies Final Version 2.0 Specification, effective January 1, 2019. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Uninterruptible%20Power%20Supplies%20Final%20Version%202.0%20Specification.pdf

[629] Calculation and inputs provided in ENERGY STAR Uninterruptible Power Supplies Final Version 2.0 Specification.

[630] California Municipal Utilities Association. Savings Estimation Technical Reference Manual 2017, Third Edition. Section 8.12, p. 8–15. https://www.cmua.org/files/CMUA-POU-TRM_2017_FINAL_12-5-2017%20-%20Copy.pdf

[121] The EFLH values were derived using the following equation EFLH = ($t_{0.25}$ x 0.25 + $t_{0.5}$ x 0.5 + $t_{0.75}$ x 0.75 + $t_{1.0}$ x 1.0) x 8760 hours. The time spent at specified proportion of reference load (t) was sourced from the ENERGY STAR Uninterruptible Power Supplies Final Version 2.0 Specification document. The 8760 hours assumption is based on the fact that the power is uninterruptible, therefore available year-round, i.e 8760 hours a year.

3.9.5 REFRIGERATED BEVERAGE VENDING MACHINE

Market	Commercial/Multifamily
Baseline Condition	TOS
Baseline	Code
End Use Subcategory	Plug Load
Measure Last Reviewed	January 2023

Description

This measure applies to new or rebuilt ENERGY STAR®, Class A, Class B, Combination A or Combination B refrigerated vending machines. ENERGY STAR® vending machines incorporate more efficient compressors, fan motors, and lighting systems as well as a low power mode option that allows the machine to be placed in low-energy lighting and/or low-energy refrigeration states during times of inactivity. Class A machines have 25% or more of the front surface area that is transparent; Class B machines have less than 25% of the front surface area that is transparent. Combination machines have separate refrigerated and non-refrigerated compartments.

Baseline Case

The baseline equipment is a new Class A, Class B, Combination A or Combination B refrigerated vending machine that meets Federal Energy Efficiency Standards for refrigerated vending machines as defined in 10 CFR 431.294.

Efficient Case

A new or rebuilt ENERGY STAR®, Class A, Class B, Combination A or Combination B refrigerated vending machine that meets Energy Star Vending Machine Ver 4.0 program requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kWh_b - kWh_q\right) \times Days$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-262 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kWh_b	Energy usage of baseline vending machine	Site Specific, if unknown calculate using Table 3-263	kWh/day	[631]
kWh_q	Energy usage of ENERGY STAR vending machine	Site Specific, if unknown calculate using Table 3-263	kWh/day	[632]
V	Refrigerated Volume	Site Specific, if unknown use 23.62	Ft^3	[633]
Days	Days of vending machine operation per year	365.25	days	[634]
CF	Electric coincidence factor	Look up in Table 3-264	N/A	
PDF	Gas peak day factor	Look up in Table 3-264	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[633]

Table 3-263 Energy Consumption Default Values

Equipment Class	Baseline (kWh_b) kWh/day	Energy Star (kWh_q) kWh/day
Class A	0.052 x V + 2.43	0.04836 x V + 2.2599
Class B	0.052 x V + 2.20	0.04576 x V + 1.936
Combination A	0.086 × V † + 2.66	0.07998 x V + 2.4738
Combination B	0.111 × V † + 2.04	0.09768 x V + 1.7952

Peak Factors

There are no peak demand savings because this measure is aimed to reduce demand during times of low beverage machine use, which will typically occur during off-peak hours.

Table 3-264 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 14 years [633].

References

[631] 10 CFR §431.296 - Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines.

[632] ENERGY STAR® Version 4.0 requirements for maximum daily energy consumption.

[633] Navigant Consulting, *Energy Savings Potential and R&D Opportunities for Commercial Refrigeration*. September 2009, https://www1.eere.energy.gov/buildings/publications/pdfs/corporate/commercial_refrig_report_10-09.pdf.

[634] ENERGY STAR. US Environmental Protection Agency and US Department of Energy. “ENERGY STAR Certified Vending Machines Spread Sheet” available at https://www.energystar.gov/productfinder/download/certified-vending-machines/

3.9.6 VENDING MACHINE CONTROLS

Market	Commercial/Multifamily
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure covers the installation of time clocks or occupancy sensors on refrigerated vending machines and novelty coolers to reduce compressor run time and lighting hours while ensuring units maintain desired product temperatures during occupied hours. This measure also covers the installation of either controls on non-refrigerated (snack) vending machines. In this case, savings are derived from a reduction in lighting hours during unoccupied hours. This measure is only applicable to vending machines and novelty coolers containing non-perishable products without a low power mode.

The time clock control mechanism is a programmed-schedule time clock that is assumed to be set to turn the equipment off coincident with the facility closing time and turn equipment on one hour before opening time to allow the products to return to the desired sale temperature.

The occupancy sensor control mechanism uses an infrared sensor to turn off the vending machine when the surrounding area is unoccupied. The device also monitors the ambient temperature and powers up the machine as required to keep products cool. Additionally, the sensor monitors the electrical current used by the machine to ensure it is not turned off during a compressor cycle to prevent a high head pressure start from occurring.

Baseline Case

The baseline equipment is assumed to be a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Efficient Case

The efficient equipment is assumed to be a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Refrigerated Vending Machine and Novelty Cooler

$$\Delta kWh = kW_{unit} \times \left[hrs_{off} + F_{ctrl} \times ESF \times (8{,}760 - hrs_{off})\right]$$

Non-Refrigerated Vending Machine

$$\Delta kWh = kW_{unit} \times \left[hrs_{off} + F_{ctrl} \times ESF \times (8{,}760 - hrs_{off})\right]$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-265 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kW_{unit}	Vending machine power (kW)	Look up in Table 3-266	kW	[635][637]
hrs_{off}	Annual facility closed hours (Daily facility closed hours minus 1 multiplied by operating days)	Site-specific, if unknown see Appendix D: HVAC Fan and Pump Operating Hours	hours	
F_{ctrl}	Control type factor	Occupancy Sensor = 1 Time Clock = 0	N/A	
ESF	Energy savings of occupancy sensing control during building operating hours	0.1	N/A	[636]
CF	Electric coincidence factor	Look up in Table 3-267	N/A	
PDF	Gas peak day factor	Look up in Table 3-267	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-266 Vending Machine Power

Peak Factor	Value
Refrigerated beverage vending machine	0.4
Non-refrigerated snack vending machine	0.02
Glass front refrigerated coolers	0.46

Peak Factors

Table 3-267 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 5 years [638].

References

[635] *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 9: Volume 2 Commercial and Industrial Measures* (2020) Pg. 574 https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010121_v9.0_Vol_2_C_and_I_09252020_Final.pdf

[636] Department of Energy, *Wireless Sensors for Lighting Energy Savings, Wireless Occupancy Sensors for Lighting Controls: An Applications Guide for Federal Facility Managers*, December 2019. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/wireless_occupancy_sensor_guide.pdf

[637] Southern California Edison, *Workpaper SCE17CS005, Revision 1, Beverage Merchandise Controller*, July 23, 2018. http://deeresources.net/workpapers

[638] Energy Resource Solutions, *Measure Life Study: Prepared for the Massachusetts Joint Utilities*, November 2005, https://www.ers-inc.com/wp-content/uploads/2018/04/Measure-Life-Study_MA-Joint-Utilities_ERS.pdf.

3.9.7 ELECTRIC VEHICLE CHARGER

Market	Commercial/Multifamily
Baseline Condition	NC/RF
Baseline	ISP/Existing
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

Electric Vehicle Supply Equipment (EVSE) is the infrastructure that is used to charge electric vehicle batteries. At non-residential locations, EVSE may simply be a designated outlet in a parking lot or garage, or may include embedded intelligence that allows a fee to be charged for use of the EVSE and communications with a charging network such as ChargePoint. Additional functionality (the ability to charge a fee or communicate with a network) adds substantially to the cost of EVSE installation and often includes a monthly subscription fee.

Baseline Case

Level 1 - 120 volts Electric Vehicle Supply Equipment at a public or commercial location.

Efficient Case

Level 2 - 240 volts Electric Vehicle Supply Equipment at a public or commercial location.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = 403 \times N_{EVSE}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-268 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
403	Deemed Annual Energy Savings	403	kWh/yr	[639]
N_{EVSE}	Number of EVSE	N/A	N/A	[639]
CF	Electric coincidence factor	Look up in Table 3-269	N/A	[639]
PDF	Gas peak demand factor	Look up in Table 3-269	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[639]

Peak Factors

Table 3-269 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	75%	[639]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is the length of the warranty for EVSE given in the EVSE manufacturer websites. If unknown, use 10 years [639].

References

[639] Vermont Energy Investment Corporation, *Transportation Technical Reference Manual: Guide to Characterize the Savings, Benefits, and Costs of Transportation Efficiency,* June 2014, Page 23 available at https://www.veic.org/Media/default/documents/resources/manuals/veic-transportation-trm.pdf

3.10 REFRIGERATION

3.10.1 ENERGY EFFICIENT GLASS DOORS ON VERTICAL OPEN REFRIGERATED CASES

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Refrigeration
Measure Last Reviewed	November 2022

Description

This measure applies to retrofitting vertical, open, refrigerated display cases with high efficiency glass doors without anti-sweat heaters. The deemed savings factors are derived from the results of a controlled test designed to measure the impact of this measure. The results of the test were presented at the 2010 International Refrigeration and Air Conditioning conference.

Baseline Case

The baseline equipment is an existing vertical display case of medium temperature with no doors. The display cases should be medium temperature (typically for dairy, meats, or beverages) as opposed to low temperature (typically for frozen food and ice cream).

Efficient Case

The compliance condition is a vertical refrigerated display case fitted with glass doors without anti-sweat heaters.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = CL \times (\Delta kWh/ft) \times \left(1 - \frac{hrs_{cooling}}{8{,}760} - \frac{COP_{ref}}{COP_{HVAC}}\right)$$

Where,

$$COP_{ref} = \frac{3.517}{(kW/ton)}$$

$$COP_{HVAC} = \frac{EER}{3.412}$$

Annual Fuel Savings

$$\Delta Therms = CL \times \frac{(\Delta kWh/ft) \times 3{,}412}{100{,}000} \times \frac{hrs_{heating}}{8{,}760} \times \frac{1}{Eff}$$

Peak Demand Savings

$$\Delta kW_{Peak} = CL \times \frac{(\Delta kWh/ft)}{8{,}760} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-270 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWhLife	Lifetime electric energy savings	Calculated	kWh	
ΔThermsLife	Lifetime fuel savings	Calculated	Therms	
CL	Case Length, open length of the refrigerated case	Site-specific	ft	

Variable	Description	Value	Units	Ref
ΔkWh/ft	Annual electric energy savings per foot of door opening	Look up in Table 3-271	kWh/yr-ft	[640]
COP_{ref}	Coefficient of performance of refrigeration equipment	Calculated	N/A	
kW/ton	Rated efficiency of the compressor in input kW per ton of refrigeration capacity	Site-specific	kW/ton	
COP_{HVAC}	Coefficient of performance of heating, ventilation, and cooling equipment	Site-specific. If unknown, look up in Table 3-272	N/A	[641]
Eff	Fossil fuel-fired heating system efficiency	Site-specific[122]. If unknown, use 0.8		[642]
$Hrs_{cooling}$	Cooling HVAC load hours	Site-specific	Hours	
$Hrs_{heating}$	Heating HVAC load hours	Site-specific	hrs	
3,412	Conversion factor from kWh to Btu	3,412	Btu/kWh	
8,760	Number of hours in a year	8760	Hours	
100,000	Conversion factor from Btu to therms	100,000	Btu/therm	
CF	Coincidence factor	Look up in Table 3-273	N/A	
PDF	Peak day factor	Look up in Table 3-273	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-271 Annual electric energy savings per foot of door opening

Door Type	ΔkWh/ft[123]
High-Efficiency Doors on Cooler	477
High-Efficiency Doors on Freezer	747
Standard Doors on Cooler	183
Standard Doors on Freezer	392

Table 3-272 Coefficient of performance of HVAC systems

Location[124]	COP_{HVAC}
Grocery Store	2.93

[122] E_c, E_t or AFUE shall be used, based on nameplate rating metric of existing equipment

[123] Fricke, Brian and Becker, Bryan, "Energy Use of Doored and Open Vertical Refrigerated Display Cases". Energy savings of high efficiency doors are calculated by eliminating anti-condensation heater energy draw and proportionally reducing associated work required from the refrigeration equipment while assuming an HVAC system COP of 3.28, refrigeration COP of 3.03 for coolers and 1.66 for freezers. Measured energy savings on medium temperature units was adjusted with COPcooler/COPfreezer ratios to develop savings for standard doors installed on freezer units.

[124] Grocery Store default assumes a 25-ton packaged RTU (cooling only); Other default assumes a 10-ton packaged RTU (cooling only)

Location[124]	COP_{HVAC}
Other	3.57

Peak Factors

Table 3-273 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0[125]	[643]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-274 Measure Life

Equipment	EUL	RUL	Ref
Case Doors	4	1.3	[644]

References

[640] Fricke, Brian and Becker, Bryan, "Energy Use of Doored and Open Vertical Refrigerated Display Cases" (2010). International Refrigeration and Air Conditioning Conference. Paper 1154. http://docs.lib.purdue.edu/iracc/1154

[641] ASHRAE 90.1 2010 Energy Standard for Buildings Except Low Rise Residential Buildings: Standard for Unitary HVAC. https://www.ashrae.org/technical-resources/standards-and-guidelines

[642] Gas boiler efficiency of 80% -ASHRAE Standards 90.1-2007 and 2016, Energy Standard for Buildings Except Low Rise Residential Buildings, Table 6.8.1F. https://www.ashrae.org/technical-resources/standards-and-guidelines

[643] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 10, January 2023

[644] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020. http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

[125] No source specified – update pending availability and review of applicable references.

3.10.2 DOOR CLOSER

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Controls
Measure Last Reviewed	January 2023

Description

Th*is section provides energy savings algorithms for the installation of auto-closer to the main insulated opaque door(s) of a walk-in freezer or cooler. Auto-closers can reduce the amount of time that doors are open, thereby reducing infiltration and refrigeration loads. This measure applies to retrofit of doors not previously equipped with auto-closers, and assume the doors have strip curtains.*

The auto-closer must be able to firmly close the door when it is within one inch of full closure. The walk-in door pe*rimeter must be ≥ 16 feet.*

Baseline Case

Walk in cooler/freezer without an auto closer and the doors have strip curtains.

Efficient Case

Walk in cooler/freezer with an auto closer.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Cooler *Door:*

$$\Delta kWh = \Delta kWh_{cooler}$$

Freezer Door:

$$\Delta kWh = \Delta kWh_{freezer}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

Cooler *Door:*

$$\Delta kW_{Peak} = \Delta kW_{cooler}$$

Freezer Door:

$$\Delta kW_{Peak} = \Delta kW_{freezer}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = N/A$$

Calculation Parameters

Table 3-275 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔkWh_{cooler}	Annual kWh savings for main cooler doors	737	kWh/yr	[645][646]
$\Delta kWh_{freezer}$	Annual kWh savings for main freezer doors	1,997	kWh/yr	[645][646]
ΔkW_{cooler}	Summer peak kW savings for main cooler doors	0.463	kW	[645][646]
$\Delta kW_{freezer}$	Summer peak kW savings for main freezer doors	0.488	kW	[645][646]
CF	Electric coincidence factor	Lookup in Table 3-276	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Peak demand is accounted for in the deemed savings values in this measure.

Table 3-276 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	[645]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 8 years [647].

References

[645] *Technical Reference Manual Volume 3: Commercial and Industrial Measures* (State of Pennsylvania, 2019), Pg 172 https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[646] Southern California Edison, “Refrigerated Storage Auto Closer”, Workpaper SCE17RN024, Measure R79 (Cooler) & R80 (Freezer). http://www.deeresources.net/workpapers.

[647] "DEER2014-EUL-table-update_2014-02-05". 2014. Deeresources.com. Accessed December 12, 2022. http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx

3.10.3 DOOR GASKETS

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Load reduction
Measure Last Reviewed	January 2023

Description

This measure involves the replacement of worn-out gaskets with new, better-fitting gaskets on the doors of walk-in and/or reach-in coolers and freezers. When damaged and/or missing, the warmer, more humid air present in the store will infiltrate the case, increasing the refrigeration system load while often reducing the efficiency of the evaporator unit as a result of additional frost accumulation. Replacing the damaged gaskets reduces compressor run time and improves the overall heat removal effectiveness of the cooler/freezer.

Baseline Case

The baseline condition is a low-temperature walk-in and/or reach-in freezer and/or a medium-temperature walk-in and/or reach-in with damaged and/or missing gaskets with at least six inches of damage for reach-in units and at least two feet of damage for walk-in units.

Efficient Case

The efficient case is the installation of new, tight fitting door gaskets to reduce infiltration.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{\Delta kWh}{Door} \times Doors$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kW}{Door} \times Doors$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-277 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
ΔkWh/Door	Annual Energy Savings per Foot of gasket	Lookup in Table 3-278	kWh	[648][649]
ΔkW/Door	Demand Savings per Foot of gasket	Lookup in Table 3-278	kW	[648][649]
Doors	Total number of gasket doors replaced	Site-specific	N/A	[648][649]
CF	Electric coincidence factor	Lookup in Table 3-279	N/A	
EUL	Effective useful life	See Measure Life Section	Years	[650]
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-278 Door Gasket Savings Per Foot of Gasket for Walk-in and Reach-in Coolers and Freezers

Type	Coolers		Freezers	
	ΔkW/door	ΔkWh/door	ΔkW/door	ΔkWh/door
Reach-in	0.032	248	0.032	243
Walk-in	0.027	204	0.045	347

Peak Factors

Table 3-279 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-280 Measure Life

Equipment	EUL	RUL	Ref
Door Gaskets	4	1.3	[650]

References

[648] Database for UES Measures, Regional Technical Forum. Door Gasket Replacement, version 1.5. December 2016. https://rtf.nwcouncil.org/measure/door-gasket-replacement

[649] Pennsylvania TRM 2021, August 2019 available at https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[650] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

3.10.4 NIGHT COVERS

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Refrigeration
Measure Last Reviewed	November 2022

Description

This measure covers the installation of retractable curtains on open horizontal or multi-deck refrigerated display cases in grocery stores. These covers serve as a barrier between the contents of the refrigerated case and the ambient air during off-business hours. They conserve energy by reducing the infiltration of ambient air into the refrigerated space, thereby reducing the load on the refrigeration system. Grocery stores operating 24 hours per day are not eligible for energy savings.

Baseline Case

The baseline condition is a vertical or horizontal open refrigerated display case left uncovered during off-business hours and meeting the minimum federal energy standards presented in Table 3-282 and Table 3-283 [651]. Eq*uipment with an operating temperature above 32°F is classified as Medium with a rating temperature of 38°F, while equipment with an operating temperature of 32°F or below is classified as Low with a rating temperature of 0°F. Ice Cream freezers have a rating temperature of -15°F and operate at temperatures below -5°F.*

Total Daily Energy *Consumption (TDEC) shall be calculated per Table* 3-282 *and Table* 3-283 *for the appropriate display case type, configuration and rating temperature. For refrigeration equipment with two or more compartments (i.e. hybrid refrigerators, freezers, refrigerator-freezers and non-hybrid refrigerator freezers), the TDEC shall be established as the sum of the TDEC values associated with each component compartment.*

Efficient Case

The compliance condition is a vertical or horizontal open refrigerated display case with retractable night covers installed.

Operating Hours

Energy savings are based on installation of refrigerated case night covers in an 18-hour supermarket assumed to operate 365 days per year. Therefore, the annual hours that night covers are assumed to be in use are (24 – 18) x 365 = 2,190 hours [652].

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = TDEC \times ESF \times 365$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = 0$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithm

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-281 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
TDA[126]	Total Display Area of the open case	Site-specific	Ft^2	
units	Number night covers installed	Site-specific	N/A	

[126] TDA = L * H, where L is length of the display case opening (ft) and H is height (vertical) or depth (horizontal) of the display case opening (ft). These parameters are site specific.

Variable	Description	Value	Units	Ref
TDEC	Total Daily Energy Consumption	Look up in Table 3-282, Table 3-283	kWh/day	[651]
ESF	Energy Savings Factor	0.09	N/A	[652]
365	Number of days in a year	365	days/yr	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-282 Baseline Efficiencies for Refrigerators, Freezers, or Refrigerator-freezers Manufactured on or after March 27, 2017

Equipment Family	Condensing Unit Configuration	Rating Temperature	TDEC (kWh/day)
Vertical Open	Remote Condensing	Medium (38°F)	0.64 x TDA + 4.07
Vertical Open	Remote Condensing	Low (0°F)	2.20 x TDA + 6.85
Vertical Open	Remote Condensing	Ice Cream (-15°F)	2.79 x TDA + 8.70
Vertical Open	Self-Contained	Medium (38°F)	1.69 x TDA + 4.71
Vertical Open	Self-Contained	Low (0°F)	4.25 x TDA + 11.82
Vertical Open	Self-Contained	Ice Cream (-15°F)	5.40 x TDA + 15.02
Horizontal Open	Remote Condensing	Medium (38°F)	0.35 x TDA + 2.88
Horizontal Open	Remote Condensing	Low (0°F)	0.55 x TDA + 6.88
Horizontal Open	Remote Condensing	Ice Cream (-15°F)	0.70 x TDA + 8.74
Horizontal Open	Self-Contained	Medium (38°F)	0.72 x TDA + 5.55
Horizontal Open	Self-Contained	Low (0°F)	1.90 x TDA + 7.08
Horizontal Open	Self-Contained	Ice Cream (-15°F)	2.42 x TDA + 9.00

Table 3-283 Baseline Efficiencies for Refrigerators, Freezers, and Refrigerator-freezers Manufactured before March 27, 2017

Equipment Family	Condensing Unit Configuration	Rating Temperature	TDEC (kWh/day)
Vertical Open	Remote Condensing	Medium (38°F)	0.82 × TDA + 4.07
Vertical Open	Remote Condensing	Low (0°F)	2.27 × TDA + 6.85
Vertical Open	Remote Condensing	Ice Cream (-15°F)	2.89 × TDA + 8.70

Equipment Family	Condensing Unit Configuration	Rating Temperature	TDEC (kWh/day)
Vertical Open	Self-Contained	Medium (38°F)	1.74 × TDA + 4.71
Vertical Open	Self-Contained	Low (0°F)	4.37 × TDA + 11.82
Vertical Open	Self-Contained	Ice Cream (-15°F)	5.55 × TDA + 15.02
Horizontal Open	Remote Condensing	Medium (38°F)	0.35 × TDA + 2.88
Horizontal Open	Remote Condensing	Low (0°F)	0.57 × TDA + 6.88
Horizontal Open	Remote Condensing	Ice Cream (-15°F)	2.44 × TDA + 9.00
Horizontal Open	Self-Contained	Medium (38°F)	0.77 × TDA + 5.55
Horizontal Open	Self-Contained	Low (0°F)	1.92 × TDA + 7.08
Horizontal Open	Self-Contained	Ice Cream (-15°F)	2.44 × TDA + 9.00

Peak Factors

Table 3-284 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-285 Measure Life

Equipment	EUL	RUL	Ref
Night Covers	5	1.67	[653]

References

[651] 10 CFR 431.66 Energy conservation standards and their effective dates. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431#431.66

[652] Southern California Edison, Effects of the Low Emissivity Shields on Performance and Power Use of a Refrigerated Display Case, August 1997. https://www.econofrost.com/acrobat/sce_report_long.pdf

[653] DEER 2014 EUL ID: GrocDisp-DispCvrs.

3.10.5 STRIP CURTAINS

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Load Reduction
Measure Last Reviewed	January 2023

Description

This measure involves the installation of strip curtains on the main door of walk-in freezers and walk-in coolers. Strip curtains prevent infiltration of non-refrigerated air into refrigerated spaces when the main door is open for routine stocking activity. In the absence of strip curtains, the warmer, more humid air present in the store will infiltrate the unit, increasing the load of the refrigeration system and often reducing the efficiency of the evaporator unit as frost accumulates, impairing its effectiveness. The total refrigeration load due to infiltration through the main door into the unit depends on the temperature differential between the refrigerated and non-refrigerated space, the door area and height, and the duration and frequency of door openings. The avoided infiltration depends on the efficacy of the newly installed strip curtains as infiltration barriers. Algorithms and assumptions in this measure are drawn from a Strip Curtains measure maintained by the Northwest Regional Technical Forum (RTF), which calculates savings using the formulas outlined in ASHRAE's Refrigeration Handbook for calculating refrigeration load from infiltration by air exchange.

Baseline Case

The baseline case is a walk-in cooler or freezer that previously had either no strip curtain installed or on old ineffective strip curtain installed. The baseline condition efficiency is a walk-in cooler or freezer door with damaged or missing strip curtains in excess of 15% of the door area. The most likely areas of application are large and small grocery stores, supermarkets, restaurants, and refrigerated warehouses.

Efficient Case

The efficient equipment is a strip curtain added to a walk-in cooler or freezer. Strip curtains must be at least 0.06 inches thick. Low-temperature strip curtains must be used on low-temperature applications.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{\Delta kWh}{ft^2} \times A$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{ft^2} \times \frac{A}{Hrs}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-287 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta kWh/ft^2$	Average annual kWh savings per square foot of insulation barrier	Look up in Table 3-288	kWh/ft^2	[654]
A	Doorway area	Site-specific, if unknown look up in Table 3-289	ft^2	[654]
Hrs	Annual hours of operation	Site-specific, if unknown use 8766	Hours	
CF	Electric coincidence factor	Look up in Table 3-290	N/A	
PDF	Gas peak demand factor	Look up in Table 3-290	N/A	

Variable	Description	Value	Units	Ref
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-288 Default Annual Energy Savings for Strip Curtains per Square Foot

Type	Energy Savings for no pre-exisitng curtains, $\frac{\Delta kWh}{ft^2}$	Energy Savings for pre-exisitng curtains, $\frac{\Delta kWh}{ft^2}$
Grocery - Cooler	119.88	40.87
Grocery - Freezer	494.32	168.52
Convenience Store - Cooler	23.58	6.27
Convenience Store - Freezer	33.15	9.99
Restaurant - Cooler	22.50	6.19
Restaurant - Freezer	114.01	32.37
Refrigerated Warehouse - Cooler	153.36	53.42

Table 3-289 Doorway Area Assumptions

Type	Doorway Area, ft^2
Grocery - Cooler	21
Grocery - Freezer	21
Convenience Store - Cooler	21
Convenience Store - Freezer	21
Restaurant - Cooler	21
Restaurant - Freezer	21
Refrigerated Warehouse - Cooler	120

Peak Factors

Table 3-290 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-291 Measure Life

Equipment	EUL	RUL	Ref
Strip Curtains	4	1.33	[655]

References

[654] IL TRM v10, pg 650.

[655] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx. Accessed December 2018.

3.10.6 ANTI-SWEAT HEAT CONTROL

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Refrigeration
Measure Last Reviewed	January 2023

Description

Anti-sweat door heaters (ASDH) prevent condensation on cooler and freezer doors. Anti-sweat heater (ASH) controls sense the humidity in the store outside of reach-in, glass door refrigerated cases and turn off anti-sweat heaters during periods of low humidity. Without controls, anti-sweat heaters run continuously whether they are necessary or not.

There are two commercially available control strategies – (1) ON/OFF controls and (2) micro pulse controls that respond to a call for heating, which is typically determined using either a door moisture sensor or an indoor air temperature and humidity sensor to calculate the dew point. In the first strategy, the ON/OFF controls turn the heaters on and off for minutes at a time, resulting in a reduction in run time. In the second strategy, the micro pulse controls pulse the door heaters for fractions of a second, in response to the call for heating. Savings are realized from the reduction in energy used by not having the heaters running at all times. In addition, secondary savings result from reduced cooling load on the refrigeration unit when the heaters are off.

Baseline Case

The baseline condition is assumed to be a commercial glass door cooler or refrigerator and freezer with a standard heated door running 24 hours a day, seven days per week (24/7), with no controls installed.

Efficient Case

The efficient equipment is assumed to be a door heater control on a commercial glass door cooler or refrigerator and freezer utilizing either ON/OFF or micro pulse controls.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kW_d \times \left(\%ON_b - \%ON_q\right) \times N \times Hrs \times IF_e$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = kW_d \times IF_e \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-292 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kW_d	Connected load kW per connected door	Site-specific, if unknown use 0.13	kW/door	[656]
N	Number of doors	Site-specific	N/A	
$\%ON_b$	Effective runtime of the uncontrolled ASDH	Site-specific, if unknown use 90.7%	N/A	[656]
$\%ON_q$	Effective runtime of the controlled ASDH	Look up in Table 3-293	N/A	[656]
IF_e	Interactive effects factor for energy to account for cooling savings from offset refrigeration load	Look up in Table 3-294	N/A	[656]

Variable	Description	Value	Units	Ref
CF	Electric coincidence factor	Look up in Table 3-295	N/A	[656]
Hrs	Hours of operation	8,760	Hrs	
EUL	Effective useful life	See Measure Life Section	Years	[657]

Table 3-293 Effective run time of controlled ASDH

Control Type	Value	Ref
ON/OFF control style	58.9%	[656]
Micropulse control style	42.8%	[656]
Unknown control style	45.6%	[656]

Table 3-294 Interactive effects factor for energy[127]

System Type	IF_eValue	Ref
Cooler or Refrigerator	1.26	[656]
Freezer	1.51	[656]

Coincidence Factor

Table 3-295 Coincidence Factors[128]

Control Type	CF Value	Ref
ON/OFF control style	0.32	[656]
Micropulse control style	0.45	[656]
Unknown control style	0.44	[656]

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

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[127] Interactive effects factor for energy is calculated by dividing the PJM Summer Peak kW equipment and interactive savings for ASDH by the equipment savings from Table 52 of the report reference [656].

[128] Coincidence factors developed by dividing the PJM Summer Peak kW Savings for ASDH Controls from Table 52 of the reference [656] (0.057 kW/door for unknown control style, 0.041 kW/door for on/off controls, and 0.058 kW/door for micropulse controls) by the average wattage of ASDH per connected door (0.13 kW)

Table 3-296 Measure Life

Equipment	EUL	RUL	Ref
Anti-sweat heat control	12	4	[657]

References

[656] Commerical Refrigeration Loadshape Project, 2015 available at https://cadmusgroup.com/wp-content/uploads/2016/02/NEEP-CRL_Report_FINAL_clean.pdf?submissionGuid=cb214243-bab8-479a-a4c4-c8e5c64ae7b2

[657] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020 available at http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.10.7 DEFROST CONTROLS

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure is applicable to existing refrigerated cases, walk in freezers, and walk in coolers with a traditional electric defrost mechanism. This control system overrides defrost of evaporator coils when unnecessary, reducing annual energy consumption. The estimates for savings take into account savings from reduced number of defrost cycles as well as the reduction in heat gain from the defrost process.

Baseline Case

The baseline case is an electric defrost system that uses a time clock mechanism to initiate defrost.

Efficient Case

The high-efficiency case is a defrost system with electric defrost controls.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{Defrost} + \Delta kWh_{Heat}$$

Where,

$$\Delta kWh_{Defrost} = kW_{Defrost} \times Hours \times DRF$$

$$\Delta kWh_{Heat} = \Delta kWh_{Defrost} \times 0.28 \times Eff_{RS}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{8760}\ X\ CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-297 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta kWh_{Defrost}$	Energy savings resulting from an increase in operating efficiency due to the addition of electronic defrost controls.	Calculated	kWh	
ΔkWh_{Heat}	Energy savings due to reduced heat from reduced number of defrost cycles	Calculated	kWh	
$kW_{Defrost}$	Load of electric defrost	Site-specific, if unknown use 0.9 kW	kW	
Hours	Number of hours defrost occurs over a year without the defrost controls	From Application, if unknown use 487[129]	Hrs/yr	[660]

[129] The refrigeration system is assumed to be in operation every day of the year, while savings from the evaporator coil defrost control will only occur during set defrost cycles. This is assumed to be (4) 20-minute cycles per day, for a total of 487 hours.

Variable	Description	Value	Units	Ref
DRF	Defrost reduction factor- percent reduction in defrosts required per year	35%		[658]
Eff_{RS}	Efficiency of typical refrigeration system	From Application, if unknown 3.35 (cooler), 1.88 (freezer)	kW/ton	[661]
0.28	Conversion constant	0.28	ton/kW	
CF	Electric coincidence factor	Look up in Table 3-298	N/A	
PDF	Gas peak demand factor	Look up in Table 3-298	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Peak Factors

Table 3-298 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-299 Measure Life

Equipment	EUL	RUL	Ref
Defrost Controls	10	3.33	[659]

References

[658] Supported by third party evaluation: Independent Testing was performed by Intertek Testing Service on a Walk-in Freezer that was retrofitted with Smart Electric Defrost capability

[659] Vermont Technical Reference User Manual (TRM), March 16, 2015. Pg. 171. This is a conservative estimate is based on a discussion with Heatcraft based on the components expected life

[660] Brian A. Fricke, Vishal Sharma, *Demand Defrost Strategies in Supermarket Refrigeration Systems*. (Oct 2011), Pg 2, https://info.ornl.gov/sites/publications/files/pub31296.pdf.

[661] Naikaj Pandya and Jon Maxwell *X1931-5 PSD Commercial Refrigeration Efficiency Update Study* (EnergizeCT, 2022) https://energizect.com/sites/default/files/documents/CT%20x1931-5%20Commercial%20Refrigeration%20ACOP%20Final%20Report_051222.pdf

3.10.8 LED CASE LIGHTING

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	N/A
Measure Last Reviewed	January 2023

Description

This measure applies to the installation of LED lamps in vertical and horizontal display refrigerators, coolers, and freezers replacing T8 or T12 linear fluorescent lamps. Replacing fluorescent lamps with low heat generating LEDs reduces the energy consumption associated with the lighting components and reduces the amount of heat generated from the lamps that must be overcome through additional cooling.

Baseline Case

Existing T8 or T12 refrigerated case linear fluorescent lamps.

Efficient Case

DesignLights Consortium (DLC) version 5.1 qualified LED vertical or horizontal refrigerated case luminaires.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{W_b - W_q}{1{,}000}\right) \times units \times hrs \times \left(1 + \left(Eff_{comp} \times 0.284\right)\right)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \left(\frac{W_b - W_q}{1{,}000}\right) \times units \times CF \times \left(1 + \left(Eff_{comp} \times 0.284\right)\right)$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-300 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
W_b	Rated baseline fixture wattage	Site-specific, if unknown: T8 Case Lighting System = 15.2/Linear Feet T12HO Case Lighting System = 18.7/Linear Feet	Watts	[666]
W_q	Rated energy efficient wattage	Site-specific	Watts	
Units	Number of LED fixtures installed under the program	Site-specific	N/A	
Hrs	Hours of use	Site-specific, if unknown assume 6,205	Hrs/yr	[662]
Eff_{comp}	Compressor efficiency	Site-specific, if unknown look up in Table 3-301	kW/ton	[663]
0.284	Conversion factor from kW to tons of refrigeration	0.284	Tons/kW	
CF	Electric coincidence factor	Look up in Table 3-302	N/A	
PDF	Gas peak demand factor	Look up in Table 3-302	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-301 Compressor Efficiency

Case Type	Eff_{comp}
Cooler	1.00
Freezer	1.92

Peak Factors

Table 3-302 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.92	[664]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is smaller of the measure EUL (16 years [665]) and the case RUL.

References

[662] Theobald, M. A., Emerging Technologies Program: Application Assessment Report #0608, LED Supermarket Case Lighting Grocery Store, Northern California, Pacific Gas and Electric Company, January 2006. Assumes refrigerated case lighting typically operates 17 hours per day, 365 days per year.

[663] Based on CDH Energy evaluation of actual refrigeration system performance for several commercially available compressors, dated 09/06/2017. Values presented reflect average efficiencies of R22 systems.

[664] Pennsylvania PUC, Technical Reference Manual, June 2016, p. 258.

[665] DEER 2014 EUL ID: GrocDisp-FixtLtg-LED

[666] Pacific Gas & Electric. May 2007. LED Refrigeration Case Lighting Workpaper 053007 rev1. Values normalized on a per linear foot basis.

3.10.9 REFRIGERATED CASE LIGHT OCCUPANCY SENSORS

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure documents the energy savings attributed to installing occupancy sensors to control LED refrigerated case lighting. Energy savings can be achieved from the installation of sensors that dim or turn off the lights when the space or aisle is unoccupied. Energy savings result from a combination of reduced lighting energy and reduced cooling load within the case.

Baseline Case

No motion-based controls.

Efficient Case

This measure requires the installation of motion-based lighting controls that allow the LED case lighting to be dimmed or turned off completely during unoccupied conditions.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{W}{1{,}000} \times Hrs \times RRF \times (1 + IF_e)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

There are no peak demand savings associated, as the savings are assumed to occur off-peak.

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-303 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
W	Connected wattage of controlled refrigerated lighting fixtures	Site-specific	Watts	
Hrs	Annual operating hours	Site-specific. If unknown assume 6,205	Hours	[667]
IF_e	Interactive effects factor for energy to account for colling savings from offset refrigeration load	Lookup in Table 3-304	N/A	[668]
RRF	Runtime reduction factor	Lookup in Table 3-305	N/A	[669]
1,000	Conversion factor	1,000	W/kW	
CF	Electric coincidence factor	Lookup in Table 3-306	N/A	
PDF	Gas peak day factor	Lookup in Table 3-306	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-304 Interactive Effects Factor

Refrigerator and Cooler	Freezer
0.29	0.50

Table 3-305 Runtime Reduction Factor

24 Hour Facility	18 Hour Facility
0.39	0.29

Peak Factors

Table 3-306 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-307 Measure Life

Equipment	EUL	RUL	Ref
Refrigeratred Case Lighting	8	2.66	[670]

References

[667] Matteson, Mary, Marc Senior, and Energy Analyst. n.d. *Pacific Gas and Electric Company Emerging Technologies Program Application Assessment Report #0608 LED Supermarket Case Lighting Grocery Store, Northern California Pacific Gas and Electric Company.* Assumes 6,205 annual operating hours and 50,000 lifetime hours. Most case lighting runs continuously (24/7) but some can be controlled. 6,205 annual hours of use can be used to represent the mix. Using grocery store hours of use (4,660 hr) is too conservative since case lighting is not tied to store lighting. https://www.etcc-ca.com/sites/default/files/OLD/images/stories/pdf/ETCC_Report_204.pdf

[668] 2021 Pennsylvania TRM, Volume 3, Commercial and Industrial Measures. Table 3 8: Interactive Factors for All Bulb Types. https://www.puc.pa.gov/pcdocs/1692532.docx

[669] “ComGroceryDisplayCaseMotionSensors_v3_3.Xlsm | Powered by Box.” n.d. Nwcouncil.app.box.com. Accessed January 20, 2023. https://nwcouncil.app.box.com/s/brl01usbhxvtrjbp0i2xcqk016lndfd1

[670] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020. http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.10.10 EVAPORATOR FAN EC MOTOR

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure covers energy and demand savings associated with the replacement of existing shaded-pole (SP) evaporator fan motors or Permanent Split Capacitor (PSC) motors in refrigerated cases with an Electronically Commutated motor (ECM) or a Permanent Magnet Synchronous (PMS) motor. The baseline condition assumes the evaporator fan motor is uncontrolled (i.e., it runs continuously). This measure applies to equipment manufactured before January 1, 2009 only, as the Code of Federal Regulations requires the use of EC or three-phase motors in evaporator fans in equipment manufactured on or after that date. Savings are calculated per motor replaced.

There are two sources of energy and demand savings through this measure:

1) The direct savings associated with replacement of an inefficient motor with a more efficient one;

2) The indirect savings of a reduced cooling load on the refrigeration unit due to less heat gain from the more efficient evaporator fan motor in the air-stream.

Baseline Case

The baseline case is a walk-in cooler/freezer or refrigerated display case with shaded pole (SP) or permanent split capacitor (PSC) evaporator fan motors.

Efficient Case

The efficient case is a walk-in cooler/freezer or refrigerated display case with Permanent Magnet Synchronous (PMS) motor or electronically commutated evaporator fan motors (ECM) with full load efficiency exceeding that prescribed by federal energy conservation standards for electric motors in 10 CFR 431.446 and/or 10 CFR 431.25 as applicable.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \left(kW_b - kW_q\right) \times F_{uncontrolled} \times 8{,}760 \times IF_e$$

If motor power is unknown, calculate using the algorithms below:

$$kW_b = HP_b \times \frac{0.746}{Eff_b} \times LF$$

$$kW_q = HP_q \times \frac{0.746}{Eff_q} \times LF$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{8{,}760}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-308 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kW_b	Input wattage of the baseline motor	Site-specific, if unknown, calculated from motor HP	kW	

Variable	Description	Value	Units	Ref
kW_q	Input wattage of the efficient motor	Site-specific, if unknown, calculated from motor HP	kW	
$F_{uncontrolled}$	Effective runtime fraction of the uncontrolled motor	Site-specific, if unknown, use 0.978	N/A	[671]
HP_b	Rated horsepower of the baseline motor	Site-specific, if unknown use 1/15 HP	HP	
HP_q	Rated horsepower of the efficient motor	Site-specific	HP	
LF	Load factor	Site-specific[130], if unknown, use 0.9		[673]
IF_e	Interactive effects factor for energy to account for cooling savings from offset refrigeration load	Look up in Table 3-309	N/A	[671]
8,760	Annual operating hours of Evaporator Fan	8,760	hours	
0.746	Unit conversion, kW/HP	0.746	kW/HP	
Eff_b	Efficiency of the baseline motor	SP: 30% PSC: 60%	N/A	[672]
Eff_q	Efficiency of the qualifying motor	ECM: 70% PMS: 73%	N/A	[672]
CF	Electric coincidence factor	Look up in Table 3-310	N/A	
PDF	Gas peak day factor	Look up in Table 3-310	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-309 Interactive Factor for Energy

Equipment Type	IF_e Value
SP Base, Cooler	0.38
PSC Base, Cooler	0.19
SP Base, Freezer	0.76
PSC Base, Freezer	0.38

[130] Load Factor is the ratio between the actual load and rated load. This can be estimated by spot metering and nameplate reading.

Peak Factors

Table 3-310 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1.0	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is smaller of the RUL of the host equipment or 16 years [674].

References

[671] Cadmus, *Commercial Refrigeration Loadshape Project* (2015). https://cadmusgroup.com/wp-content/uploads/2016/02/NEEP-CRL_Report_FINAL_clean.pdf

[672] Department of Energy. “Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment.” December 2013. Motor efficiencies for the baseline motors are drawn from Table 2.1, which provides peak efficiency ranges for a variety of motors. The motor efficiency for an ECM is drawn from the discussion in 2.4.3. https://www.energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf

[673] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential Multifamily, and Commercial/Industrial Measures. Version 6*. (April 16, 2018)

[674] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.10.11 EVAPORATOR FAN CONTROLLER

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

This measure is for the installation of evaporator fan controls in walk-in refrigerators or freezers with no pre-existing controls. An evaporator fan controller is a device or system that lowers airflow across an evaporator when there is no refrigerant flow through the evaporator (i.e., when the compressor is in an off-cycle). Evaporator fans run constantly to provide cooling when the compressor is running, and to provide air circulation when the compressor is not running. There are two commercially available strategies – ON/OFF controls and multispeed controls – that respond to a call for cooling. In the first strategy, the ON/OFF controls turn the motors on and off in response to the call for cooling, generating energy and demand savings as a result of a reduction in run time. In the second strategy, the multispeed controls change the speed of the motors in response to the call for cooling, saving energy and reducing demand by reducing operating power and run time (multispeed controls can also turn the motor off).

A fan controller saves energy by reducing fan usage, by reducing the refrigeration load resulting from the heat given off by the fan and by reducing compressor energy resulting from the electronic temperature control. This measure documents the energy savings attributed to evaporator fan controls.

Baseline Case

The baseline case is assumed to be a shaded pole (SP) motor or PSC motor in walk-in evaporators without controls or an electronically-commutated motor (ECM) without controls.

Efficient Case

The efficient equipment is assumed to be an evaporator fan powered by an ECM, SP or PSC motor utilizing either ON/OFF or multispeed controls.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = kW \times \left(\%ON_b - \%ON_q\right) \times Hrs \times IF_e$$

Where,

$$kW = HP \times LF \times 0.746/\eta$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-311 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
kW	Input wattage of the SP, PSC or ECM motor	Site-specific, if unknown calculated	kW	
0.746	Conversion factor	0.746	kW/HP	[677]
LF	Load Factor - Ratio between the actual load and the rated load.	Site-specific, if unknown use 0.9	N/A	[677]

Variable	Description	Value	Units	Ref
HP	Horsepower of SP, PSC or ECM motor	Site-specific	HP	
η	Motor efficiency of the SP, PSC or ECM motor	SP: 30% PSC: 60% ECM: 70%		[678]
$\%ON_b$	Effective runtime of the uncontrolled motor	Site-specific, if unknown use 97.8%	N/A	[675]
$\%ON_q$	Effective runtime of the controlled motor	Site-specific, if unknown look up in Table 3-312	N/A	[675]
IF_e	Interactive effects factor for energy to account for cooling savings from offset refrigeration load	Look up in Table 3-313	N/A	[675]
CF	Electric coincidence factor	Look up in Table 3-314	N/A	[675]
Hrs	Hours of operation	8,760	Hrs	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-312 Effective run time of controlled motors

Control Type	Value	Ref
ON/OFF style controls	63.6%	[675]
Multi-speed style controls	69.2%	[675]

Table 3-313 Interactive Effects Factor for Energy[131]

System Type	IF_e Value	Ref
Cooler or Refrigerator	1.38	[675]
Freezer	1.76	[675]

Coincidence Factor

Table 3-314 Coincidence Factors[132]

Control Type	CF Value	Ref
ON/OFF control style	0.087	[675]
Micropulse control style	0.102	[675]

[131] Interactive effects factor for energy is calculated by dividing the annual energy savings (kWh/HP) for "Equipment and Interactive" (shown in Table 43 of the reference [656]) by annual energy savings (kWh/HP) for the "Equipment Only" equipment type (also shown in Table 43).

[132] Coincidence factors are developed by dividing the PJM summer peak kW/HP savings for evaporator fan controls (shown in Table 47 of the report reference [656]) by the average annual energy savings (kWh/HP) for evaporator fan controls (shown in Table 43 of the report reference [656]).

Control Type	CF Value	Ref
Unknown control style	0.094	[675]

Measure Life

The effective useful life (EUL) is smaller of the RUL of the host equipment or 16 years [676].

References

[675] Commercial Refrigeration Loadshape Project, 2015 available at https://cadmusgroup.com/wp-content/uploads/2016/02/NEEP-CRL_Report_FINAL_clean.pdf?submissionGuid=cb214243-bab8-479a-a4c4-c8e5c64ae7b2

[676] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020 available at http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[677] DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*

[678] Department of Energy. “Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment.” December 2013. Motor efficiency for SP motors is drawn from Table 2.1, which provides peak efficiency ranges for a variety of motors. The motor efficiency for an ECM is drawn from the discussion in 2.4.3. https://www.energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf

3.10.12 FLOATING HEAD PRESSURE CONTROL

Market	Commerical
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Control
Measure Last Reviewed	January 2023

Description

Installers conventionally design a refrigeration system to condense at a set pressure-temperature point, typically 90°F. By installing a floating head pressure control (FHPCs) condenser system, the refrigeration system can change condensing temperatures in response to different outdoor temperatures. This means that the minimum condensing head pressure from a fixed setting (180 psig for R-22) is lowered to a saturated pressure equivalent at 70°F or less. Reduced head pressure improves the compressor efficiency at the expense of additional condenser fan power, with a net overall decrease in the compressor plus condenser fan power. Either a balanced-port or electronic expansion valve that is sized to meet the load requirement at a 70°F condensing temperature must be installed. Alternatively, a device may be installed to supplement the refrigeration feed to each evaporator attached to a condenser that is reducing head pressure.

Baseline Case

The baseline case is a refrigeration system without FHPC.

Efficient Case

The efficient case is a refrigeration system with FHPC.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = HP_{compressor} \times \frac{kWh}{HP}$$

If the refrigeration system is rated in tonnage:

$$\Delta kWh = \frac{4.715}{COP} \times Tons \times \frac{kWh}{HP}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = 0$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \text{N/A}$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-315 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$HP_{compressor}$	Rated horsepower per compressor	Site-specific	HP	
Tons	Refrigerator tonnage of the system	Site-specific	ton	
kWh/HP	Annual Savings per HP	Look up in Table 3-316	kWh/HP	[679][682]
COP	Coefficient of Performance	Look up in Table 3-317	N/A	[679][681]
4.715	Unit Conversion, HP/ton	4.715	HP/ton	
CF	Electric coincidence factor	Look up in Table 3-318	N/A	
PDF	Gas peak demand factor	Look up in Table 3-318	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Annual Savings per HP

Table 3-316 Annual Savings per HP

System Type/Size	kWh/hp
Unitary Condenser, Low Temp, 0-3 hp	252.03

System Type/Size	kWh/hp
Unitary Condenser, Low Temp, >3-6 hp	241.86
Unitary Condenser, Low Temp, >6-10 hp	248.68
Unitary Condenser, Low Temp, >10 hp	282.24
Unitary Condenser, Medium Temp, 0-3 hp	131.45
Unitary Condenser, Medium Temp, >3-6 hp	127.32
Unitary Condenser, Medium Temp, >6-10 hp	128.1
Unitary Condenser, Medium Temp, >10 hp	132.58
Remote Condenser, Low Temp, 0-3 hp	505.37
Remote Condenser, Low Temp, >3-6 hp	481.06
Remote Condenser, Low Temp, >6-10 hp	484.96
Remote Condenser, Low Temp, >10 hp	503.32
Remote Condenser, Medium Temp, 0-3 hp	393.38
Remote Condenser, Medium Temp, >3-6 hp	387.53
Remote Condenser, Medium Temp, >6-10 hp	396.89
Remote Condenser, Medium Temp, >10 hp	404.66

Table 3-317 COP for refrigeration equipment

System Type	Freezer (Low Temp)	Refrigerator (Medium Temp)	Ref
Unitary Condenser	1.4	2.6	[679]
Remote Condenser	1.88	3.35	[681]

Peak Factors

Table 3-318 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	

Peak Factor	Value	Ref
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 15 years [680] or one-third of the EUL of the host equipment.

References

[679] Regional Technical Forum (RTF) as part of the Northwest Power & Conservation Council, Commerical Grocery Floating Head Pressure Controls Single Compressor v3.0, April 18, 2022; available at https://rtf.nwcouncil.org/measure/floating-head-pressure-controls-single-compressor-systems/ Assumed the kWh/hp savings for NJ will be equivalent to the kWh/hp savings derived for NYC location.

[680] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020 available at http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

[681] DNV. 2022. "X1931-5 PSD Commercial Refrigeration Efficiency Update Study." Connecticut Energy Efficiency Board.

[682] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 10, January 2023 available at https://www3.dps.ny.gov/W/PSCWeb.nsf/PFPage/72C23DECFF52920A85257F1100671BDD?OpenDocument

3.10.13 VFD COMPRESSOR

Market	Commercial
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Refrigeration
Measure Last Reviewed	January 2023

Description

Variable frequency drive (VFD) compressors are used to control and reduce the speed of the compressor during times when the refrigeration system does not require the motor to run at full capacity. VFD control is an economical and efficient retrofit option for existing compressor installations. The performance of variable speed compressors can more closely match the variable refrigeration load requirements thus minimizing energy consumption.

Baseline Case

Existing rotary screw compressor with slide valve control system.

Efficient Case

Rotary screw compressor with VFD control system.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = 0.212 \times \frac{1}{COP} \times HP_{compressor} \times ES_{value}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = 0.212 \times \frac{1}{COP} \times HP_{compressor} \times DS_{value} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-319 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$HP_{compressor}$	Rated horsepower per compressor	Site-specific	hp	
ES_{value}	Energy savings value	1,696	kWh/ton	[683]
DS_{value}	Demand savings value	0.22	Kw/ton	[683]
COP	Coefficient of performance	Site-specific, if unknown look up in Table 3-320	N/A	[684]
0.212	Conversion factor from HP to ton	0.212	Ton/hp	
CF	Electric coincidence factor	Look up in Table 3-321	N/A	
PDF	Gas peak demand factor	Look up in Table 3-321	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-320 COP for refrigeration equipment

Equipment	COP
Coolers	3.35
Freezers	1.88

Peak Factors

Table 3-321 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is smaller of the RUL of the host rotary screw compressor or 15 years [685].

References

[683] 2005 DEER (Database for Energy Efficiency Resources). This measure considered the associated savings by vintage and by climate zone for compressors. The deemed value was an average across all climate zones and all vintages (excluding new construction). http://www.deeresources.com/index.php/deer2005

[684] Connecticut Energy Efficiency Board (EEB) "PSD Commercial Refrigeration Efficiency Update Study", May 2022 https://energizect.com/sites/default/files/documents/CT%20x1931-5%20Commercial%20Refrigeration%20ACOP%20Final%20Report_051222.pdf

[685] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020 available at http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.11 WATER HEATING

3.11.1 STORAGE WATER HEATER

Market	Commercial/Multifamily
Baseline Condition	NC/TOS/EREP
Baseline	Code/Existing/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of gas and electric storage tank water heaters designed to heat and store water at a thermostatically controlled temperature. This measure applies to potable hot water delivery only; it is not applicable to hot water heaters used for process loads or space heating.

Storage type units include commercial gas-fired storage water heaters with a nominal input of greater than 75,000 BTU/h and no more than one gallon of water per 4,000 BTU/h of input, and commercial electric storage water heaters with a nominal input of greater than 12 kilowatts and no more than one gallon of water per 4,000 BTU/h of input.

This measure applies to replacement of existing storage type water heaters using the same heating as the efficient case. For new construction, this measure assumes baseline to be a standard efficiency water heater using the same heating fuel as the efficient equipment.

This measure applies to commercial grade water heaters only. For residential-duty water heaters installed in commercial settings, the Residential Storage Tank and Instantaneous Domestic Water Heater methodology detailed in this document shall be employed utilizing typical GPD values as defined in the "Gallons per Day (GPD)" section below.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

New Construction, Time of Sale:

The baseline condition for replacement measures is a standard efficiency fossil fuel or electric storage type water heater (based on proposed conditions) with tank volume and input capacity equivalent to the efficient case, UA value calculated as prescribed in the savings algorithm and a thermal efficiency of 0.80 (fossil fuel) or 0.98 (electric).

Early Replacement

The baseline condition for the Early Replacement measure is the existing water heater for the remaining useful life of the unit, and then for the remainder of the measure life the baseline becomes a new replacement unit meeting the minimum federal efficiency standard.

Efficient Case

The compliance condition is a fossil fuel or electric storage type water heater as defined in the Measure Description section above, which exceeds the efficiency of the baseline equipment.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left(\frac{1}{E_{t,b}} - \frac{1}{E_{t,q}}\right)$$

Where,

$$\Delta T_{main} = T_{set} - T_{main}$$

$$SL_b = \frac{Q_b}{800} + 110\sqrt{v_b}$$

Annual Fuel Savings

$$\Delta Therms_{NR} = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left(\frac{1}{E_{t,b}} - \frac{1}{E_{t,q}}\right)$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\left(UA_b - UA_q\right) \times \Delta T_{amb}}{3{,}412} \times CF$$

Where,

$$\Delta T_{amb} = T_{set} - T_{amb}$$

$$UA_q = \frac{SL_q}{70}$$

$$UA_b = \frac{SL_b}{70}$$

For baseline of large electric storage type water heaters (> 12kW and > 20 gallons):

$$SL_b = \frac{\left(0.3 + \frac{27}{v_b}\right)}{100} \times 70 \times v_b \times 8.33$$

For baseline of large oil and gas storage type water heaters (> 75,000 BTU/h input capacity (Q) and storage size > 1 gallon per 4000 BTU/h):

$$SL_b = \frac{Q_b}{800} + 110\sqrt{v_b}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-322 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
ΔT_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main	Calculated	°F	
ΔT_{amb}	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature	Calculated	°F	

Variable	Description	Value	Units	Ref
UA_b	Overall heat loss coefficient of the baseline condition	Calculated	Btu/h-°F	
GPD	Gallons per day	Site Specific, if unknown look up in Table 3-323	Gal/day	[696][697][698][699]
UA_q	Overall heat loss coefficient of the energy efficient measure	Site-specific	Btu/h-°F	
SL_b	Standby loss of baseline unit	Code baseline: calculated Existing baseline: site-specific, calculated if unknown	kBtu/hr	
SL_q	Standby loss of efficient unit from AHRI rating	Site-specific	kBtu/hr	
T_{set}	Water heater set point temperature	Site-specific, if unknown use 125	°F	[690]
$E_{t,b}$	Thermal efficiency of the baseline condition	Site-specific. If unknown, look up in Table 3-324	N/A	[228][354]
$E_{t,q}$	Thermal efficiency of the energy efficient condition	Site-specific	N/A	
v_b	Baseline tank volume, equal to the storage capacity of the efficient equipment	Site-specific	gal	
Q_b	Baseline input capacity, equal to the input capacity of the efficient equipment	Site-specific	Btu/hr	
T_{main}	Supply water temperature in water main[133]	60	°F	[222]
T_{amb}	Surrounding ambient air temperature	70	°F	[691]
365	Days per year	365	Days/yr	
3,412	Conversion factor	3,412	Btu/kWh	
8.33	Energy required (Btu) to heat one gallon of water by one degree Fahrenheit	8.33	Btu/gal°F	
100,000	Conversion factor	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 3-325	N/A	
PDF	Gas peak day factor	Look up in Table 3-325	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life	See Measure Life Section	Years	

[133] Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6 °F.

Table 3-323 GPD[134]

Building Type	GPD	Rate	Notes/Assumptions	Source	REf
Assembly	239	7.02 GPD per 1,000 SF	Assumes 34,000 SF	EIA926: Public Assembly	[686]
Auto Repair	25	4.89 GPD per 1,000 SF	Assumes 5,150 SF	EIA: Other	[686]
Big Box Retail	448	3.43 GPD per 1,000 SF	Assumes 130,500 SF	EIA: Mercantile	[686]
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL927: School with Showers	[687]
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation928	[688]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School	[687]
Fast Food Restaurant	500	500 GPD per restaurant		FSTC929: Quick Service	[689]
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service	[689]
Grocery	172	3.43 GPD per 1,000 SF	Assumes, 50,000 SF	EIA: Mercantile	[686]
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers	[687]
Hospital	16,938	54.42 GPD per 1,000 SF	Assumes 250,000 SF	EIA: Health Care, Inpatient	[686]
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 200,000 SF	EIA: Lodging	[686]
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office	[687]
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 130,000 SF	EIA: Mercantile	[686]
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 100,000 SF	EIA: Other	[686]
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 30,000 SF	EIA: Lodging	[686]
Multifamily High-Rise	4,600	46 GPD per unit	Assumes 100 units	Water Research Foundation	[688]
Multifamily Low-Rise	552	46 GPD per unit	Assumes 12 units	Water Research Foundation	[688]
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 92,000 SF	EIA: Warehouse and Storage	[686]
Religious	77	7.02 GPD per 1,000 SF	Assumes 11,000 SF	EIA: Public Assembly	[686]
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office	[687]
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 8,000 SF	EIA: Mercantile	[686]

[134] The estimates in this table rely on sources that present total water consumption. Site-specific GPD estimate should be used if possible. Calculated GPD estimate should be compared to water heater capacity to ensure it is reasonable, and reduced if needed to align with water heater capacity.

Building Type	GPD	Rate	Notes/Assumptions	Source	REf
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School	[687]
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 500,000 SF	EIA: Warehouse and Storage	[686]
Other	Calculate	4.89 GPD per 1,000 SF		EIA: Other	[686]

Table 3-324 Thermal efficiency baseline

Electric	Gas
0.98	0.80

Peak Factors

Table 3-325 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[695]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Equipment	EUL	RUL	Ref
Commercial Storage Water Heater	15	5	[693]

References

[686] U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings, Table WD1. Daily water consumption in large commercial buildings, 2012

[687] National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011

[688] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016

[689] Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010

[690] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature, December 2022.

[691] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.

[692] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B/appendix-Appendix%20E%20to%20Subpart%20B%20of%20Part%20430

[693] 10 CFR 431.110 (a) – Energy conservation standards and their effective dates. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-G/subject-group-ECFR4c2d09a7e7a11ca/section-431.110California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx.

[694] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022

[695] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 9, January 2022. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf.

3.11.2 TANKLESS WATER HEATER

Market	Commercial/Multifamily
Baseline Type	NC/TOS/RF/DI/EREP
Baseline	Code/Existing/Dual
End Use Subcategory	Water Heating
Measure Last Reviewed	December 2022

Description

This measure covers the installation of high-efficiency fossil fuel and electric instantaneous water heaters, which heat water but contain no more than one gallon of water per 4,000 Btu/h of input. It is applicable to fossil fuel-fired instantaneous water heaters with a rated input greater than 200,000 Btu/h and electric instantaneous water heaters with a rated input greater than 12 kW. This measure applies to potable hot water delivery only; it is not applicable to water heaters used for process loads or space heating.

This measure applies to replacement of existing storage type water heaters using the same heating fuel (fossil fuel or electric) as the efficient case. For new construction, this measure assumes baseline to be a standard efficiency water heater using the same heating fuel (fossil fuel or electric) as the efficient case.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The baseline condition is a standard efficiency fossil fuel or electric storage type water heater (fuel type equivalent to the efficient case) with tank volume and input capacity equivalent to those of the existing equipment, UA value calculated as prescribed below and a thermal efficiency of 0.80 (fossil fuel) or 0.98 (electric). If existing tank volume is unknown, assume a 120-gallon storage type water heater with an input capacity of 200,000 Btu/h.

Efficient Case

The compliance condition is a fossil fuel or electric instantaneous water heater as defined in the Measure Description section above. Fossil fuel tankless water heaters must meet the minimum qualifying efficiency for ENERGY STAR® certification of a thermal efficiency greater than or equal to 0.94. Electric tankless water heaters must meet or exceed the efficiency of the baseline condition with a thermal efficiency greater than or equal to 0.98.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = kWh_b - kWh_q$$

$$\Delta kWh = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left(\frac{1}{E_{t,b}} - \frac{1}{E_{t,q}}\right) + \frac{UA_b \times \Delta T_{amb} \times 8{,}760}{E_{t,b} \times 3{,}412}$$

Where,

$$kWh_b = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412 \times E_{t,b}} + \frac{UA_b \times \Delta T_{amb} \times 8{,}760}{E_{t,b} \times 3{,}412} \ (Electric\ Baseline)$$

$$kWh_b = 0 \ (Fossil\ Fuel\ Baseline)$$

$$kWh_q = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412 \times E_{t,q}} (Electric\ Energy\ Efficient\ Case)$$

$$kWh_q = 0 \ (Fossil\ Fuel\ Energy\ Efficient\ Case)$$

$$\Delta T_{main} = T_{set} - T_{main}$$

$$\Delta T_{amb} = T_{set} - T_{amb}$$

$$UA_b = \frac{SL_b}{70}$$

For baseline of large electric storage type water heaters (> 12kW and > 20 gallons):

$$SL_b = \frac{\left(0.3 + \frac{27}{v_b}\right)}{100} \times 70 \times v_b \times 8.33$$

Annual Fuel Savings

$$\Delta Therms = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left(\frac{1}{E_{t,b}} - \frac{1}{E_{t,q}}\right) + \frac{UA_b \times \Delta T_{amb} \times 8{,}760}{E_{t,b} \times 100{,}000}$$

Where,

$$\Delta Therms = Therms_b - Therms_q$$

$$Therms_b = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000 \times E_{t,b}} + \frac{UA_b \times \Delta T_{amb} \times 8{,}760}{E_{t,b} \times 100{,}000} (Fossil\ Fuel\ Baseline)$$

$$Therms_b = 0 \ (Electric\ Baseline)$$

$$Therms_q = \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000 \times E_{t,q}} (Fossil\ Fuel\ Energy\ Efficient\ Case)$$

$$Therms_q = 0 \ (Electric\ Energy\ Efficient\ Case)$$

$$\Delta T_{main} = T_{set} - T_{main}$$

$$\Delta T_{amb} = T_{set} - T_{amb}$$

$$UA_b = \frac{SL_b}{70}$$

For baseline of large oil and gas storage type water heaters (> 75,000 BTU/h input capacity (Q) and storage size > 1 gallon per 4000 Btu/h):

$$SL_b = \frac{Q_b}{800} + 110\sqrt{v_b}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{8{,}760} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-326 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔT_{main}	Average temperature difference between water heater set point and the supply water temperature in water main	Calculated	°F	
ΔT_{amb}	Average temperature difference between water heater set point and the surrounding ambient air temperature	Calculated	°F	
UA_b	Overall heat loss coefficient of the baseline condition, calculate based on baseline standby loss	Calculated	N/A	
$E_{t,q}$	Thermal efficiency for energy efficient measure	Site-specific	N/A	
GPD	Gallons per day	Site-specific, if unknown look up in Table 3-327	Gal/day	[696][697] [698][699]
v_b	Baseline tank volume	Site-specific, if unknown use 120	gal	
Q_b	Baseline input capacity	Site-specific, if unknown use 200,000	Btu/h	
$E_{t,b}$	Thermal efficiency of the baseline condition	For retrofit, use site-specific existing value. If unknown, use 0.80 for fossil fuel and 0.98 for electric. For new construction, look up in Appendix E: Code-Compliant Efficiencies	N/A	[702]
T_{set}	Water heater set point temperature	Site-specific, if unknown use 125	°F	[700]
T_{main}	Supply water temperature in water main	60	°F	[701]
T_{amb}	Surrounding ambient air temperature	70[135]	°F	

[135] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.

Variable	Description	Value	Units	Ref
365	Days per year	365	Days/yr	
3,412	Conversion from Btu to kWh	3,412	Btu/kWh	
8.33	Energy required (Btu) to heat one gallon of water by one degree Fahrenheit	8.33	Btu/gal°F	
100,000	Conversion from Btu to therms	100,000	Btu/therm	
70	Temperature difference associated with standby loss specification	70	(°F)	
CF	Coincident Factor	Look up in Table 3-328	N/A	
PDF	Peak day factor	Look up in Table 3-328	N/A	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

The average daily hot water usage, expressed in gallons per day, for several commercial facility types is tabulated below. Daily hot water usage can be calculated based on the GPD and site-specific metric in the Rate column, or default values can be referenced directly from the GPD column.

Table 3-327 GPD by Facility Type[136]

Building Type	GPD	Rate	Notes	Source	Ref
Assembly	239	7.02 GPD per 1,000 SF	Assumes 34,000 SF, 10% hot water	EIA: Public Assembly	[696]
Auto Repair	25	4.89 GPD per 1,000 SF	Assumes 5,150 SF, 10% hot water	EIA: Other	[696]
Big Box Retail	448	3.43 GPD per 1,000 SF	Assumes 130,500 SF, 10% hot water	EIA: Mercantile	[696]
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL School with Showers	[697]
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation	[698]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School	[697]
Fast Food Restaurant	500	500 GPD per restaurant		FSTC: Quick Service	[699]
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service	[699]
Grocery	172	3.43 GPD per 1,000 SF	Assumes 50,000 SF, 10% hot water	EIA: Mercantile	[696]

[136] The estimates in this table rely on sources that present total water consumption. Site-specific GPD estimate should be used if possible. Calculated GPD estimate should be compared to water heater capacity to ensure it is reasonable, and reduced if needed to align with water heater capacity.

Building Type	GPD	Rate	Notes	Source	Ref
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers	[697]
Hospital	16,938	54.42 GPD per 1,000 SF	Assumes 40% hot water, 250,000 SF	250,000 SF EIA: Health Care, Inpatient	[696]
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 40% hot water, 200,000 SF	EIA: Lodging	[696]
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office	[697]
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 130,000 SF, 10% hot water	EIA: Mercantile	[696]
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 100,000 SF, 10% hot water	EIA: Other	[696]
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 30,000 SF, 40% hot water	EIA: Lodging	[696]
Multifamily High-Rise	4,550	45.5 GPD per unit	Assumes 100 units	Water Research Foundation	[698]
Multifamily Low-Rise	546	45.5 GPD per unit	Assumes 12 units	Water Research Foundation	[698]
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 92,000 SF, 10% hot water	EIA: Warehouse and Storage	[696]
Religious	77	7.02 GPD per 1,000 SF	Assumes 11,000 SF,10% hot water	EIA: Public Assembly	[696]
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office	[697]
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 8,000 SF, 10% hot water	EIA: Mercantile	[696]
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School	[697]
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 500,000 SF, , 10% hot water	EIA: Warehouse and Storage	[696]
Other	Calculate	4.89 GPD per 1,000 SF	Assumes 10% hot water	EIA: Other	[696]

Peak Factors

Table 3-328 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[703]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for retrofit projects is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-329 Measure Life

Equipment	New construction EUL	Retrofit RUL	Ref
Instantaneous Water Heater	20	6.66	[704]

References

[696] U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings, Table WD1. Daily water consumption in large commercial buildings, 2012.

[697] National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011.

[698] *Water Research Foundation: Residential End Uses of Water, Version 2*, (April 2016) Pg 5. https://www.circleofblue.org/wp-content/uploads/2016/04/WRF_REU2016.pdf

[699] Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010.

[700] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature, December 2022.

[701] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022.

[702] Fuel: 10 CFR 431.110 (a), December 2022.

[703] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 10, January 2023. https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V10.pdf

[704] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020. http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx

3.11.3 HEAT PUMP WATER HEATER

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/EREP/DI
Baseline	Code/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	January 2023

Description

This measure covers the installation of electric storage tank water heaters that use heat pump technology to move heat from the air (in conditioned or unconditioned spaces) to the water storage tank and are designed to heat and store potable water at a thermostatically controlled temperature of less than 180°F. It is not intended for equipment delivering process or space heating hot water. The best applications of heat pump water heater is in a space where cooling is desired year round. Heat pump water heater interactions with the HVAC system should be calculated according to the existing HVAC system (TOS) in existing buildings or the planned HVAC system in new construction (NC).

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

Baseline equipment for TOS/NC projects is a minimally code-compliant, electric storage type water heater. For EREP/DI projects, the baseline equipment is a minimally code-compliant water heater of the same type and fuel as the existing equipment.

Efficient Case

The efficient condition is an ENERGY STAR version 5.0 qualified commercial heat pump water heater.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{dhw} + \Delta kWh_{cooling} - \Delta kWh_{heating}$$

Where,

$$Load_{dhw} = GPD \times 365 \times 8.33 \times (T_{set} - T_{main})$$

$$\Delta kWh_{dhw} = \frac{Load_{dhw}}{3{,}412} \times \left(\frac{F_{dhw,electric}}{UEF_b} - \frac{1}{COP_q \times F_{derate}}\right)$$

$$\Delta kWh_{cooling} = \frac{Load_{dhw}}{1{,}000} \times \left(1 - \frac{1}{COP_q}\right) \times F_{location} \times \frac{F_{cool}}{IEER}$$

$$\Delta kWh_{heating} = \frac{Load_{dhw}}{1{,}000} \times \left(1 - \frac{1}{COP_q}\right) \times F_{location} \times F_{heat,electric} \times \frac{F_{heat}}{COP\ x\ 3.412}$$

Annual Fuel Savings

$$\Delta Therms = \Delta Therms_{dhw} - \Delta Therms_{heating}$$

Where,

$$\Delta Therms_{dhw} = \frac{Load_{dhw}}{100{,}000} \times \left(\frac{F_{dhw,ff}}{UEF_b} + \frac{F_{dhw,boiler}}{E_t}\right)$$

$$\Delta Therms_{heating} = \frac{Load_{dhw}}{100{,}000} \times \left(1 - \frac{1}{COP_q}\right) \times F_{location} \times F_{heat,ff} \times \frac{F_{heat}}{E_t}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \Delta kWh \times F_{ETD}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-330 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{dhw}	Annual domestic hot water electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{cooling}$	Annual cooling electric energy savings	Calculated	kWh/yr	
$\Delta kWh_{heating}$	Annual heating electric energy impacts	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{dhw}$	Annual domestic hot water fuel savings	Calculated	Therms/yr	
$\Delta Therms_{heat}$	Annual space heating fuel impacts	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Load_{dhw}$	Annual hot water load	Calculated	Btu	
GPD	Gallons per day	Look up in Table 3-331	Gal/day	[710]
v_r	Rated storage volume	Site-specific	Gal	
E_t	Thermal efficiency of space heating boiler or furnace	Site-specific, if unknown, look up in Table 3-337	N/A	[707]
COP_q	Coefficient of Performance of efficient unit	Site-specific, if unknown look up in Table 3-334	N/A	[706]
UEF_b	Uniform energy factor of baseline unit	Look up in Table 3-333	N/A	[706]
F_{derate}	Efficiency derating factor	Look up in Table 3-339	N/A	[707]
$F_{location}$	Installation location factor	Look up in Table 3-339	N/A	
$F_{DHW,electric}$	Electric water heating factor	Look up in Table 3-332	N/A	
$F_{DHW,ff}$	Fossil fuel water heating factor	Look up in Table 3-332	N/A	
$F_{DHW,boiler}$	Fossil fuel boiler heating factor	Look up in Table 3-332	N/A	

Variable	Description	Value	Units	Ref
$F_{heat.electric}$	Electric heating factor	Look up in Table 3-332	N/A	
$F_{heat,ff}$	Fossil fuel heating factor	Look up in Table 3-332	N/A	
F_{heat}	Heating factor, used to account for the percentage of heat extracted from ambient air by the heat pump water heater that increases space heating load	0.49	N/A	[711]
F_{cool}	Cooling factor, used to account for the percentage of heat extracted from ambient air by the heat pump water heater that reduces space cooling load	0.51	N/A	[711]
IEER	Space cooling Integrated energy efficiency ratio	Look up in Table 3-336	Btu/W·hr	[710]
COP	Space heating COP	Look up in Table 3-334	N/A	[710]
T_{main}	Supply water temperature in water main	Look up in Table 3-338	°F	[709]
F_{ETD}	Energy to demand factor	Look up in Table 3-339	N/A	
T_{set}	Water heater setpoint temperature	Site-specific, if unknown use 125	°F	[705]
365	Days per year	365	Days/yr	
8.33	Unit conversion, Btu/gal·°F	8.33	Btu/gal·°F	
3,412	Unit conversion, Btu/kWh	3,412	Btu/kWh	
3.412	Unit conversion, Btu/W·hr	3.412	Btu/W·hr	
1000	Unit conversion, Watt/kW	1000	W/kW	
100,000	Unit conversion, Btu/therm	100,000	Btu/therm	
CF	Electric coincidence factor	Look up in Table 3-340	N/A	
PDF	Gas peak demand factor	Look up in Table 3-340	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Table 3-331 Gallons Per Day[137]

Building Type	GPD	Rate	Notes/Assumptions	Source	Ref
Assembly	239	7.02 GPD per 1,000 SF	Assumes 34,000 SF	EIA926: Public Assembly	[712]
Auto Repair	25	48.9 GPD per 1,000 SF	Assumes 5,150 SF	EIA: Other	[712]
Big Box Retail	448	34.3 GPD per 1,000 SF	Assumes 130,500 SF	EIA: Mercantile	[712]
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL927: School with Showers	[713]
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation928	[714]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School	[713]
Fast Food Restaurant	500	500 GPD per restaurant		FSTC929: Quick Service	[715]
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service	[715]
Grocery	172	3.43 GPD per 1,000 SF	Assumes, 50,000 SF	EIA: Mercantile	[712]
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers	[713]
Hospital	16,938	54.42 GPD per 1,000 SF	Assumes 250,000 SF	EIA: Health Care, Inpatient	[712]
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 200,000 SF	EIA: Lodging	[712]
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office	[713]
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 130,000 SF	EIA: Mercantile	[712]
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 100,000 SF	EIA: Other	[712]
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 30,000 SF	EIA: Lodging	[712]
Multifamily High-Rise	4,600	46 GPD per unit	Assumes 100 units	Water Research Foundation	[714]
Multifamily Low-Rise	552	46 GPD per unit	Assumes 12 units	Water Research Foundation	[714]
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 92,000 SF	EIA: Warehouse and Storage	[712]
Religious	77	7.02 GPD per 1,000 SF	Assumes 11,000 SF	EIA: Public Assembly	[712]
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office	[713]
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 8,000 SF	EIA: Mercantile	[712]
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School	[713]

[137] The estimates in this table rely on sources that present total water consumption. Site-specific GPD estimate should be used if possible. Calculated GPD estimate should be compared to water heater capacity to ensure it is reasonable, and reduced if needed to align with water heater capacity.

Building Type	GPD	Rate	Notes/Assumptions	Source	Ref
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 500,000 SF	EIA: Warehouse and Storage	[712]
Other	Calculate	4.89 GPD per 1,000 SF		EIA: Other	[712]

Table 3-332 DHW and Heating Savings Factors

Baseline Scenario	$F_{DHW,electric}$	$F_{DHW,g}$	$F_{DHW,boiler}$	$F_{heat,electric}$	$F_{heat,g}$
NC/TOS: Use electric baseline	1.0	0	0	1.0	0
EREP/DI with electric baseline	1.0	0	0	1.0	0
EREP/DI with gas baseline	0	1.0	1.0	0	1.0

Table 3-333 Baseline UEF

Rated Storage Volume (v_r)	UEF_b
> 20 and ≤ 55 gallons	$0.96 - (0.0003 \times v_r)$
> 55 and < 120 gallons	$2.057 - (0.00113 \times v_r)$

Table 3-334 Efficient COP_q

Product Class	COP_q
Commercial Heat Pump Water Heater	3.0

Table 3-335 Derating Factors

Area	F_{derate}	$F_{location}$
Unconditioned Space	0.77	0
Conditioned Space	1.16	1
Kitchen	1.45	1
Unknown (Midstream Delivery)	1.00	1

Table 3-336 IEER and COP Values

Type	IEER	COP
Air Conditioner	12.7	1.0
Air-Source Heat Pump	12.7	3.3

Table 3-337 E_t Values

Equipment Type	Size Range	E_t
Warm Air Furnace, Gas Fired	All Capacities	0.80
Boiler, Hot Water, Gas Fired	All Capacities	0.80
Boiler, Steam, Gas Fired	All Capacities	0.77

Table 3-338 Supply Water Temperature

Climate Region	T_{main}
Northern	56
Southwest	58
Coastal	60
Central	58
Pine Barrens	58
Statewide Average	58

Table 3-339 F_{ETD} by building type

Building Type	ETDF
Education - Other	0.0002545
Health - Hospital	0.0002011
Health - Other	0.0003020
Lodging	0.0001210
Miscellaneous/Other	0.0002590
Office	0.0002490
Restaurant	0.0001525
Retail	0.0002560
Warehouse - Refrigerated	0.0003018

Peak Factors

Peak coincidence is incorporated in the energy to demand factor presented above.

Table 3-340 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-341 Measure Life

Equipment	EUL	RUL	Ref
Heat Pump Water Heater	10	3.37	[708]

References

[705] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature, December 2022.

[706] 10 CFR Subpart C of Part 430, https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

[707] ENERGY STAR Program Requirements Product Specification for Commercial Water Heaters, Eligibility Criteria, Version2.0. (2021),

[708] California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx. Accessed November 13, 2018

[709] NSRDB, TMY3 data, December 2022. https://nsrdb.nrel.gov/data-sets/tmy

[710] International Energy Conservation Code (IECC) 2022

[711] From NY TRM V10, Pg 128

[712] U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings, Table WD1. Daily water consumption in large commercial buildings, 2012

[713] National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011

[714] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016

[715] Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010

3.11.4 FAUCET AERATORS AND SHOWERHEADS

Market	Commercial/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	December 2022

Description

This measure covers the installation of low-flow faucet aerators and showerheads in commercial, industrial, and multifamily applications. In multifamily applications, only units installed in common areas are eligible for this measure. Savings for low-flow faucet aerator and showerhead measures are determined using the total change in flow rate (gallons per minute) from the baseline (existing) fixture to the efficient fixture.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow residential protocol.

Baseline Case

The aerator baseline is a standard faucet with a 2.2 gpm flow rate. The showerhead baseline is an existing showerhead with a 2.5 gpm flow rate. For direct install programs, utilities may choose to measure the actual flow rate of the existing aerator faucet or showerhead and for use that in the algorithm below.

Efficient Case

The efficient condition is an energy efficient faucet aerator or showerhead meeting requirements of NJ P.L. 2021, c. 464. If actual flow rates of the baseline fixtures are used in a direct install program, then the actual flow rate of the installed aerators or showerhead can be used as well.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta H2O \times \left(T_{operating} - T_{main}\right) \times \frac{8.33}{3{,}412 \times E_{t,elec}}$$

Where,

$$\Delta H2O = \left(GPM_b \times F_{Throttle,b} - GPM_q \times F_{Throttle,q}\right) \times \frac{Minutes}{Day} \times Days$$

$$\frac{Minutes}{Day} = \frac{Minutes}{Use} \times \frac{Uses}{Day}$$

Annual Fuel Savings

$$\Delta Therms = \frac{\Delta H2O \times \left(T_{operating} - T_{main}\right) \times 8.33}{(100{,}000 \times E_{t,fuel})}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hours} \times CF$$

Where,

$$Hours_{FA} = \frac{\Delta kWh \times 0.44}{GPH}$$

$$Hours_{SH} = \frac{GPM_b \times \frac{min}{use} \times \frac{uses}{day} \times days \times 0.608}{GPH}$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \ \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-342 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔH_2O	Annual water savings	Calculated	Gal/yr	
$Hours_{FA}$	Annual electric DHW recovery hours for faucet aerators	Calculated	hr/yr	
$Hours_{SH}$	Annual electric DHW recovery hours for showerheads	Calculated	hr/yr	
GPM_b	Flowrate of baseline fixture	Site-specific. If unknown, use 2.2 (faucets) 2.5 (showerheads)	Gal/min	[724][725]
GPM_q	Flowrate of efficient fixture	Site-specific. If unknown, look up in Table 3-343	Gal/min	[716]
$F_{throttle,b}$	Flowrate restricted: ratio of user setting to full throttle flow rate for baseline fixture	0.83 (faucets) 0.90 (showerheads)	N/A	[717]
$F_{throttle,q}$	Flowrate rescrticted: ratio of user setting to full throttle flowrate for efficient fixture	0.95 (faucets) 0.90 (showerheads)	N/A	[717]
$T_{operating}$	Fixture operating temperature	Look up in Table 3-343	°F	[718]
T_{main}	Temperature of supply water temperature in water main[138]	60	°F	[719]
min/use	Average duration a fixture runs each time it is used	0.5 (faucet) 8.2 (showerhead)	min	[720]
uses/day	Number of times the fixture is used per day	Site-specific. If unknown, use 60 (faucet) or 2.4 (showerhead)	N/A	[720][721]
min/day	Average minutes of fixture use per day	Calculated. If unknown, use 30 (faucet) or 20 (showerhead)	min	[721]
days	Days fixture used per year	Site-specific. If unknown, look up in Table 3-344	days/yr	[727]
GPH	Gallon per hour recovery of electric water heater	53.9	Gal/hr	
$E_{t,elec}$	Thermal efficiency of electric water heater	0.98	N/A	[722]

[138] Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F.

Variable	Description	Value	Units	Ref
$E_{t,fuel}$	Thermal efficiency of fossil fuel water heater	0.80	N/A	[722]
3,412	Conversion factor from Btu/h to kW	3,412	Btu/h/kW	
100,000	Conversion factor from Btu to therms	100,000	Btu/therm	
CF	Coincidence factor	Look up in Table 3-345	N/A	[726]
PDF	Peak day factor	Look up in Table 3-345	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-343 Installed Flowrates and Fixture Operating Temperatures

Fixture Type	Location	GPM_q	T_{faucet} (°F)
Faucet aerator	Kitchen	1.8	93
	Public restroom	0.5	86
	Private restroom	1.5	86
Showerhead	Any	2.0	105

Table 3-344 Operating Days per Year

Building Type	Operating Days per Year
Assembly	355
Auto	355
Big Box	355
Community College	284
Dormitory	355
Fast Food	355
Full Service Restaurant	303
Grocery	365
Hospital	365
Hotel	365
Large Office	303
Light Industrial	251
Motel	365

Building Type	Operating Days per Year
Multi-story Retail	355
Primary School	218
Religious	355
Secondary School	218
Small Office	303
Small Retail	355
University	284
Warehouse	251

Peak Factors

Table 3-345 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF) – Faucet Aerators	Lookup in Table 3-346	[726]
Electric coincidence factor (CF) – Showerheads	0.0278	[726]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Table 3-346 Electric Coincidence Factors for Faucet Aerators

Building Type	Coincidence Factor
Small Office	0.0064
Large Office	0.0288
Fast Food Restaurant	0.0084
Sit-Down Restaurant	0.0184
Retail	0.0043
Grocery	0.0043
Warehouse	0.0064
Elementary School	0.0096
Jr High/High School	0.0288
Health	0.0144
Motel	0.0006
Hotel	0.0004
Other	0.0128

Non-Energy Impacts

Water savings:

$$\Delta H2O = units \times \left(GPM_b \times F_{throttle,b} - GPM_q \times F_{throttle,q}\right) \times \frac{min}{day} \times days$$

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-347 Measure Life

Equipment	EUL	RUL	Ref
Faucet Aerators and Showerheads	10	3.3	[723]

References

[716] Maximum flow rates for new aerators and showerheads established by New Jersey P.L. 2021, c. 464. https://pub.njleg.state.nj.us/Bills/2020/PL21/464_.PDF

[717] Energy Related Water Fixture Measurements: Securing the Baseline for Northwest Single Family Homes, American Council for an Energy-Efficient Economy, August 2008, pg. 1-265.

[718] Cadmus and Opinion Dynamics Showerhead and Faucet Aerator Meter Study Memorandum dated June 2013, Directed to Michigan Evaluation Working Group. Table 93 "HEI Updated PY2014 Variable Assumptions"

[719] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.515.6885&rep=rep1&type=pdf

[720] FEMP, Domestic Water Conservation Technologies, pg. 35.

[721] FEMP Cost Calculator: https://www.ces.ncsu.edu/wp-content/uploads/2014/03/Federal-Energy-Management-Program-Energy-Cost-Calculator-for-Faucets-and-Showerheads.htm

[722] 10 CFR 430 Subpart B Appendix E – Uniform Test Method for Measure Energy Consumption of Water Heaters: 6.3.2 *Recovery Efficiency.* https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B

[723] Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. http://www.energizect.com/sites/default/files/Measure%20Life%20Report%202007

[724] Existing faucet flow rate assumption taken from Pennsylvania Technical Reference Manual; effective June 2016, pp. 114ff. http://www.puc.pa.gov/pcdocs/1370278.docx

[725] Energy Policy Act (EPAct) of 1992. https://afdc.energy.gov/files/pdfs/2527.pdf

[726] *IL 2022 Illinois Statewide Technical Reference Manual for Energy Efficiency : Version 10* (2022), Pg 171 (faucet aerators) and pg 177 (showerheads). https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf

[727] Operating days per year estimates based on simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

3.11.5 COMBINATION BOILER

Market	Commercial/Multifamily
Baseline Type	TOS/NC/EREP
Baseline	Code/Existing/Dual
End Use Subcategory	Equipment
Measure Last Reviewed	December 2022

Description

This section provides energy savings algorithms for qualifying gas combination boilers installed in commercial and industrial settings. A combination boiler is a space heating system that also has the capability to provide instantaneous domestic hot water. The input values are based on the specifications of the actual equipment being installed, federal equipment efficiency standards, DOE2.2 simulations completed by the NJ SWE and regional estimates of average baseline water heating energy usage.

For new construction, replacement of failed equipment, and end of useful life, the baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2019 and IECC 2021, which are the current codes adopted by the State of New Jersey.

For retrofit programs where an existing boiler is replaced , the baseline efficiency is the existing boiler efficiency. For early replacement programs, the baseline efficiency is the existing boiler efficiency for the remaining life of the existing boiler and a code efficiency boiler for the remaining life of the measure.

Baseline Case

Space Heating Component:

- New Construction/Replacement of Failed Equipment/End of Useful Life: Boiler compliant with ASHRAE Std. 90.1 – 2019 and IECC 2021.
- Retrofit/Direct Install: Existing boiler efficiency for first baseline. If unknown, use minimally code-compliant efficiency based on boiler age. As second baseline, use current code for measure remaining life.

Domestic Hot Water Component:

- New Construction/Replacement of Failed Equipment/End of Useful Life: Water heater compliant with ASHRAE Std. 90.1 – 2019 and IECC 2021.
- Retrofit: Existing water heater efficiency for first baseline. If unknown use minimally code compliant efficiency based on water heater age. As second baseline, use current code for measure remaining life.

Efficient Case

The compliance condition is a combi-boiler unit with a heating efficiency higher than code. Qualifying systems must not have a water storage tank.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Annual Fuel Savings

$$\Delta Therms = \Delta Therms_{Boiler} + \Delta Therms_{DHW}$$

Where,

$$\Delta Therms_{Boiler} = Cap_{in} \times EFLH_h \times \frac{Eff_q/Eff_b - 1}{100}$$

$$\Delta Therms_{DHW} = \frac{GPD \times 365 \times 8.33 \times (T_{set} - T_{main})}{100{,}000} \times \left(\frac{1}{E_{t,b}} - \frac{1}{Eff_q}\right) + \frac{UA_b}{E_{t,b}} \times \frac{(T_{set} - T_{amb})}{100{,}000} \times 8{,}760$$

Peak Demand Savings

$$\Delta kW_{Peak} = N/A$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-348 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$\Delta Therms_{Boiler}$	Annual fuel savings from space heating	Calculated	Therms/day	
$\Delta Therms_{DHW}$	Annual fuel savings from water heating	Calculated	Therms/day	
Cap_{in}	Input capacity of qualifying boiler	Site-specific	kBtu/hr	
Eff_q	Boiler proposed efficiency	Site-specific	N/A	
$EFLH_h$	Boiler equivalent full load hours of operation during heating season	Look up in Appendix C:	Hours	[728]
Eff_b	Boiler baseline efficiency	Look up in Appendix E: Code-Compliant Efficiencies	N/A	[734][735][736]
GPD	Gallons per day of hot water use	Look up in Table 3-349	Gal/day	[737][738][739][740]
100	Unit conversion from kBtu to therm	100	kBtu/therm	
365	Days per year	365	Day/yr	
8.33	Unit conversion, Btu/gal·F	8.33	Btu/gal·F	
100,000	Unit conversion, Btu/therm	100,000	Btu/therm	
$E_{t,b}$	Baseline water heating designation thermal efficiency	0.8	N/A	[731]
T_{set}	Water heater setpoint temperature	Site-specific, if unknown use 125	°F	[729]
T_{main}	Incoming water main temperature[139]	60	°F	[730]
UA_b	Overall heat loss coefficient of the baseline condition[140]	7.85	Btu/h·F	[732]

[139] Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6 deg F.

[140] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was calculated for a minimally code compliant fuel storage water heater found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 Btu/h assumed). Results of heat loss coefficient evaluation for this assumed baseline is used to represent the UAbaseline term.

Variable	Description	Value	Units	Ref
T_{amb}	Surrounding ambient air temperature[141]	70	°F	
8,760	Hours in one year	8760	Hours	
PDF	Peak day factor	Look up in Table 3-350	N/A	
EUL	Estimated useful life	See Measure Life Section	Years	[733]

Table 3-349 Gallons Per Day (GPD)[142]

Building Type	GPD	Rate	Notes	Source	Ref
Assembly	239	7.02 GPD per 1,000 SF	Assumes 34,000 SF, 10% hot water	EIA: Public Assembly	[738]
Auto Repair	25	4.89 GPD per 1,000 SF	Assumes 5,150 SF, 10% hot water	EIA: Other	[738]
Big Box Retail	448	3.43 GPD per 1,000 SF	Assumes 130,500 SF, 10% hot water	EIA: Mercantile	[738]
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL School with Showers	[739]
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation	[740]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School	[739]
Fast Food Restaurant	500	500 GPD per restaurant		FSTC: Quick Service	[741]
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service	[741]
Grocery	172	3.43 GPD per 1,000 SF	Assumes 50,000 SF, 10% hot water	EIA: Mercantile	[738]
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers	[739]
Hospital	16,938	54.42 GPD per 1,000 SF	Assumes 40% hot water, 250,000 SF	250,000 SF EIA: Health Care, Inpatient	[738]
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 40% hot water, 200,000 SF	EIA: Lodging	[738]

[141] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.

[142] The estimates in this table rely on sources that present total water consumption. Site-specific GPD estimate should be used if possible. Calculated GPD estimate should be compared to water heater capacity to ensure it is reasonable, and reduced if needed to align with water heater capacity.

Building Type	GPD	Rate	Notes	Source	Ref
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office	[739]
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 130,000 SF, 10% hot water	EIA: Mercantile	[738]
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 100,000 SF, 10% hot water	EIA: Other	[738]
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 30,000 SF, 40% hot water	EIA: Lodging	[738]
Multifamily High-Rise	4,550	45.5 GPD per unit	Assumes 100 units	Water Research Foundation	[740]
Multifamily Low-Rise	546	45.5 GPD per unit	Assumes 12 units	Water Research Foundation	[740]
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 92,000 SF, 10% hot water	EIA: Warehouse and Storage	[738]
Religious	77	7.02 GPD per 1,000 SF	Assumes 11,000 SF,10% hot water	EIA: Public Assembly	[738]
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office	[739]
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 8,000 SF, 10% hot water	EIA: Mercantile	[738]
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School	[739]
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 500,000 SF, , 10% hot water	EIA: Warehouse and Storage	[738]
Other	Calculate	4.89 GPD per 1,000 SF	Assumes 10% hot water	EIA: Other	[738]

Peak Factors

Table 3-350 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-351 Measure Life

Equipment	EUL	RUL	Ref
Combination Boiler	22	7.3	[733]

References

[728] Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

[729] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature, December 2022.

[730] Burch, Jay and Christensen, Craig, *Towards Development of an Algorithm for Mains Water Temperature* (National Renewable Energy Laboratory). https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.515.6885&rep=rep1&type=pdf

[731] eCFR :: 10 CFR 431.110 -- Energy conservation standards and their effective dates December 1, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[732] "Regulations.gov." n.d. www.regulations.gov. Accessed December 13, 2022. Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was calculated for a minimally code compliant fuel storage water heater found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 Btu/h assumed). Results of heat loss coefficient evaluation for this assumed baseline is used to represent the UAbaseline term.

[733] https://www.regulations.gov/document/EERE-2015-BT-TP-0007-0004

[734] *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces*. (DOE, 2016), Table 8.2.17.

[735] *ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings*. (ASHRAE, 2019), Table 6.8.1-5. https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[736] *ASHRAE Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings*. (ASHRAE, 2019), Table 6.8.1-5. https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[737] *2021 INTERNATIONAL ENERGY CONSERVATION CODE (IECC) | ICC DIGITAL CODES* (IECC 2021), Table C403.3.2(6) https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency

[738] U.S. Energy Information Administration, *2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings*, Table WD1. Daily water consumption in large commercial buildings, 2012

[739] National Renewable Energy Laboratory, *Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines*, Table 1. Hot Water Use By Building Type, June 2011.

[740] Water Research Foundation: *Residential End Uses of Water, Version 2* (April 2016), Pg 5. https://www.circleofblue.org/wp-content/uploads/2016/04/WRF_REU2016.pdf

[741] Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010 E

3.11.6 PRE-RINSE SPRAY VALVES (PRSV)

Market	Commercial/Multifamily
Baseline Condition	RF/DI/TOS
Baseline	Existing/Dual
End Use Subcategory	Water Conservation
Measure Last Reviewed	December 2022

Description

This measure section documents the energy savings and demand reductions attributed to efficient low flow pre-rinse sprayers in grocery and food service applications including fast food restaurants, full-service restaurants, multifamily buildings*, and other. The most likely areas of application are kitchens in restaurants and hotels.*

Pre-rinse spra*y valves include a nozzle, squeeze lever, and dish guard bumper. The spray valves usually have a clip to lock the handle in the "on" position. Pre-rinse valves are inexpensive and easily interchangeable with different manufacturers' assemblies. The primary impacts of this measure are water savings. Energy savings depend on the facility's water heating fuel - if the facility does not have electric water heating, there are no electric savings for this measure; if the facility does not have fossil fuel water heating, there are no MMBtu (Therms) savings for this measure.*

This measure is applicable to retrofit, Time of Sale, and DI applications.

Baseline Case

The baseline for the Retrofit/Early Replacement vintage is based on the EPA 2005 standard. Baseline flowrates are site specific. If unknown, they are assumed to be 1.6 gallons/minute.

Efficient Case

High efficiency PRSV with a flowrate less than the max flow rate by product class as defined by DOE/WaterSense.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = N_{units} \times \frac{hours}{day} \times 60 \times \frac{days}{year} \times \left(GPM_b - GPM_q\right) \times 8.33 \times \frac{\Delta \mathrm{T}}{\mathrm{E_{t,elec}} \times 3{,}412}$$

Where,

$$\Delta T = T_{PRSV} - T_{Main}$$

Annual Fuel Savings

$$\Delta Therms = N_{units} \times \frac{hours}{day} \times 60 \times \frac{days}{year} \times \left(GPM_b - GPM_q\right) \times 8.33 \times \frac{\Delta T}{E_{t,fuel} \times 100{,}000}$$

Where,

$$\Delta T = T_{PRSV} - T_{Main}$$

Peak Demand Savings

$$\Delta kW_{Peak} = ETDF \times Energy\ Savings$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-352 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	

Variable	Description	Value	Units	Ref
ΔT	Average temperature different between PRSV operating temperature and the supply water temperature	60	°F	[744][746]
N_{units}	Number of fixtures	Site-specific	N/A	
GPM_q	Flow rate of the installed prsv	Site-specific. If unknown, use 1.28	Gal/min	[751]
Days/year	Number of days the fixture is in use in one year	Site-specific. If unknown, look up in Table 3-354	Days/year	[754]
$E_{t,\ elc}$	Thermal Efficiency for electrical heaters	Site-specific. If unknown, assume 98%	N/A	[752]
$E_{t,\ fuel}$	Thermal efficiency for fuel heaters	Site-specific. If unknown, assume 80%	N/A	[753]
ETDF	Energy to Demand Factor	Look up in **Error! Not a valid result for table.**	(kW/ kWh/yr)	[750]
GPM_b	Flow rate of the baseline prsv	Site-specific. If unknown, use 1.6	Gal/min	[742] [743]
Hours/day	Operating hours of fixture usage per day	Look up in Table 3-353	Hours/day	
8.33	Specific mass in pounds of one gallon of water	8.33	lbs/gal	
3,412	Btu to kWh electric conversion factor	3,412	Btu/kwh	
CF	Electric coincidence factor	Lookup in Table 3-356	N/A	
PDF	Gas peak day factor	Lookup in Table 3-356	N/A	
EUL	Effective useful life of new unit	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-353 Operating Hours/Day

Facility Type	Hours of Pre-Rinse Spray Value Use Per Day (hours)	Ref
Full Service Restaurant	4	[746]
Limited Service (fast food) Restaurant	1	[746]
Other	1.067	[747]

Table 3-354 Operating Days per Year

Building Type	Operating Days per Year
Assembly	355

Building Type	Operating Days per Year
Warehouse	251
Auto	355
Big Box	355
Community College	284
Dormitory	355
Fast Food	355
Full Service Restaurant	303
Grocery	365
Hospital	365
Hotel	365
Large Office	303
Light Industrial	251
Motel	365
Multi-story Retail	355
Primary School	218
Religious	355
Secondary School	218
Small Office	303
Small Retail	355
University	284

Table 3-355 ETDF

Facility Type	ETDF
Quick-service Restaurant	0.000186
Full-Service Restaurant	0.0001189
Standalone Retail (Grocery)	0.000237
Default – Unknown	0.000259

Peak Factors

Table 3-356 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	N/A	
Natural gas peak day factor (PDF)	Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-357 Measure Life

Equipment	EUL	RUL	Ref
PRSV	5	1.67	[750]

References

[742] The Energy Policy Act (EPAct) of 2005. http://www.psc.state.ga.us/electric/federal/EPA/EPA2005.pdf

[743] Impact and Process Evaluation Final Report for California Urban Water Conservation Council 2004-5 Pre-Rinse Spray Valve Installation Program (Phase 2), SBW Consulting, 2007, Table 3-4, p. 23. https://p2infohouse.org/ref/50/49026.pdf

[744] *CEE Commercial Kitchens Initiative Program Guidance on Pre-Rinse Spray Valves*, (CEE 2005), pg. 3. https://library.cee1.org/system/files/library/4252/PRSV%20Program%20Guidance.pdf

[745] Burch, J., and C. Christensen*, Towards Development of an Algorithm for Mains Water Temperature.* American Solar Energy Annual Conference Proceedings (2007).

[746] Hours estimates based on PG&E savings estimates, algorithms, sources (2005). Food Service Pre-Rinse Spray Valves.

[747] “WaterSense Specification for Commercial Pre-Rinse Spray Valves Supporting Statement” n.d. WaterSense® Draft Specification for Commercial Pre-Rinse Spray Valves - Supporting Statement (epa.gov)

[748] “Federal Register :: Request Access.” n.d. Unblock.federalregister.gov. Accessed December 8, 2022. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430

[749] *Technical Reference Manual Volume 3: Commercial and Industrial Measures* Pg 138 (August 2019). https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

[750] *Technical Support Document: Energy Efficiency Program For Consumer Products And Commercial And Industrial Equipment:Commercial Prerinse Spray Valves* (December 2015) Pg 8-13. https://www.regulations.gov/document/EERE-2014-BT-STD-0027-0046

[751] EPA WaterSense Specification for Commercial Pre-Rinse Spray Valves. https://www.epa.gov/watersense/pre-rinse-spray-valves

[752] *2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0: Volume 2* (2022), Pg 124, https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010122_v10.0_Vol_2_C_and_I_09242021.pdf

[753] ASHRAE Standards 90.1-2019, *Energy Standard for Buildings Except Low Rise Residential Buildings*. https://www.ashrae.org/standards-research--technology/standards--guidelines

[754] Operating days per year estimates based on simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022

3.11.7 RECIRCULATING PUMP CONTROL

Market	Commercial/Multifamily
Baseline Condition	RF/DI
Baseline	Existing/Dual
End Use Subcategory	Control
Measure Last Reviewed	December 2022

Description

This measure covers the installation of temperature modulation or demand controls on central domestic hot water (DHW) systems with recirculation:

- Temperature modulation controls reduce circulator pump energy and recirculation heat losses by modulating DHW system supply temperatures when hot water demand is expected to be low (usually based on occupancy schedules).
- Demand controls limit energy consumption by activating recirculation loops based on demand detected by a flow sensing device on the makeup water pipe and a temperature sensor installed on the recirculating return pipe.
- Temperature control. An aquastat control is used to switch the recirculating pump on and off to maintain a target temperature in the loop.
- Timer control. A timer is used to turn the recirculating pump on during peak usage times and off overnight.

Temperature modulation and demand controls achieve savings without significant interruptions to hot water availability. Recirculation systems are commonly used in larger buildings because the hot water must be quickly provided to spaces that are far from the water heating plant. The recirculation pump reduces wait time at the faucets by keeping the domestic hot water (DHW) piping loop hot as it gradually loses heat to the surrounding air. Without the recirculation pump, occupants would have to run their faucets until the cooled, stagnant water is removed from the piping between the faucet and the DHW plant and would waste water in the process; however, constant pumping operation increases energy consumption by exposing supply and return line piping to continuous heat loss, even in absence of the demand for hot water.

This measure is not applicable in facilities where twenty-four hour recirculation and delivered hot water temperature is required by code (refer to Section 7: Service Water Heating of ASHRAE 90.1 2019 to check for code requirements) [771]. This measure is not applicable to new construction or gut rehab installations.

Baseline Case

The base case for this measure category is existing, un-controlled recirculation pumps on central domestic hot water systems that continuously recirculates maintaining a constant supply temperature of the DHW.

Efficient Case

The efficient case is a central DHW recirculation system with a control system that regulates circulation pump operation based on demand and/or temperature or through timing and is in compliance with the current safety codes and standards in New Jersey**.**

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{Pump} + \Delta kWh_{HW}$$

Where,

$$\Delta kWh_{Pump} = \frac{HP \times 0.746}{Eff_{Pump}} \times LF \times Hrs_{Recirc,B} \times ESF_{Pump}$$

$$\Delta kWh_{HW} = \frac{GPD \times 365 \times 8.33 \times (T_{Set} - T_{Main})}{3{,}412} \times \frac{F_{DHW,Elec}}{E_{T,Elec}} \times \frac{Hrs_{Recirc,B}}{8{,}760} \times ESF_{HW}$$

Annual Fuel Savings

$$\Delta Therms = \frac{GPD \times 365 \times 8.33 \times (T_{Set} - T_{Main})}{100{,}000} \times \frac{F_{DHW,Fuel}}{E_{T,Fuel}} \times \frac{Hrs_{Recirc,B}}{8{,}760} \times ESF_{HW}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs_{Recirc,B}} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms:

No dual baseline:

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Dual baseline:

$$\Delta kWh_{Life} = (\Delta kWh\ using\ existing\ baseline) \times RUL + (\Delta kWh\ using\ code\ baseline) \times (EUL - RUL)$$

Lifetime Fuel Energy Savings

No dual baseline:

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Dual baseline:

$$\Delta Therms_{Life} = (\Delta Therms\ using\ existing\ baseline) \times RUL + (\Delta Therms\ using\ code\ baseline) \times (EUL - RUL)$$

Calculation Parameters

Table 3-358 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkWh_{Pump}	Annual electric energy savings from pump	Calculated	kWh/yr	
ΔkWh_{HW}	Annual electric energy savings from hot water	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Hrs_{Recirc, B}$	Annual hours of operation of recirculation system in baseline condition	Site-specific	Hrs/yr	
HP	Pump nameplate horsepower	Site-specific	HP	
Eff_{Pump}	Pump efficiency	Site-specific, if unknown look up in Table 3-359	N/A	
LF	Load factor	Site-specific, if unknown use 0.9	N/A	[757]
GPD	Average daily hot water usage	Site-specific, if unknown look up in Table 3-360	Gal/day	
T_{Set}	Water heater set point temperature	Site-specific, if unknown use 125	°F	[762]
$E_{T, Fuel}$	Thermal efficiency of fossil fuel water heater	Site-specific, if unknown use 0.8	N/A	[766]
ESF_{HW}	Hot water energy savings factor	Look up in Table 3-362	N/A	[770]

Variable	Description	Value	Units	Ref
$F_{DHW, Elec}$	Electric water heating factor	Look up in Table 3-361	N/A	
$F_{DHW, Fuel}$	Fossil fuel water heating factor	Look up in Table 3-361	N/A	
CF	Electric coincidence factor	Look up in Table 3-363	N/A	
PDF	Gas peak demand factor	Look up in Table 3-363	N/A	
T_{Main}	Supply water temperature in water main[143]	60	°F	[763]
$E_{T,Elec}$	Thermal efficiency of electric water heater	0.98	N/A	[769]
ESF_{Pump}	Pump energy savings factor	0.87	N/A	[768]
365	Days per year	365	Day/yr	
0.746	Unit conversion, kW/HP	0.746	kW/HP	
8.33	Unit conversion, Btu/gal·°F	8.33	Btu/gal·°F	
3,412	Unit conversion, Btu/kWh	3,412	Btu/kWh	
8,760	Unit conversion, Hrs/yr	8,760	Hrs/yr	
EUL	Effective useful life	See Measure Life Section	Years	
RUL	Remaining useful life of existing unit	See Measure Life Section	Years	

Table 3-359 Pump Efficiency

Pump Type	Value	Reference
PSC	0.60	[755]
ECM	0.80	[756]
Unknown	0.80	

Table 3-360 Average Daily Hot Water Usage[144]

Building Type	GPD	Rate	Notes	Source	Reference
Assembly	239	7.02 GPD per 1,000 SF	Assumes 34,000 SF, 10% hot water	EIA: Public Assembly	[758]

143 Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F.

144 The estimates in this table rely on sources that present total water consumption. Site-specific GPD estimate should be used if possible. Calculated GPD estimate should be compared to water heater capacity to ensure it is reasonable, and reduced if needed to align with water heater capacity.

Building Type	GPD	Rate	Notes	Source	Reference
Auto Repair	25	4.89 GPD per 1,000 SF	Assumes 5,150 SF, 10% hot water	EIA: Other	[758]
Big Box Retail	448	3.43 GPD per 1,000 SF	Assumes 130,500 SF, 10% hot water	EIA: Mercantile	[758]
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL School with Showers	[759]
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation	[760]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School	[759]
Fast Food Restaurant	500	500 GPD per restaurant		FSTC: Quick Service	[761]
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service	[761]
Grocery	172	3.43 GPD per 1,000 SF	Assumes 50,000 SF, 10% hot water	EIA: Mercantile	[758]
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers	[759]
Hospital	16,938	54.42 GPD per 1,000 SF		250,000 SF EIA: Health Care, Inpatient	[758]
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 40% hot water, 200,000 SF	EIA: Lodging	[758]
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office	[759]
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 130,000 SF, 10% hot water	EIA: Mercantile	[758]
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 100,000 SF, 10% hot water	EIA: Other	[758]
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 30,000 SF, 40% hot water	EIA: Lodging	[758]
Multifamily High-Rise	4,600	46 GPD per unit	Assumes 100 units	Water Research Foundation	[760]
Multifamily Low-Rise	552	46 GPD per unit	Assumes 12 units	Water Research Foundation	[760]
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 92,000 SF, 10% hot water	EIA: Warehouse and Storage	[758]

Building Type	GPD	Rate	Notes	Source	Reference
Religious	77	7.02 GPD per 1,000 SF	Assumes 11,000 SF, 10% hot water	EIA: Public Assembly	[758]
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office	[759]
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 8,000 SF, 10% hot water	EIA: Mercantile	[758]
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School	[759]
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 500,000 SF, 10% hot water	EIA: Warehouse and Storage	[758]
Other	Calculate	4.89 GPD per 1,000 SF		EIA: Other	[758]

Table 3-361 Water Heating Factors

DHW System	$F_{DHW,Elec}$	$F_{DHW,Fuel}$
Electric	1.0	0.0
Fossil Fuel	0.0	1.0

Table 3-362 Hot Water Energy Savings Factors

Control Type	ESF_{HW}
Demand Control	0.07
Temperature Modulation	0.02
Demand Control and Temperature Modulation	0.15

Peak Factors

Table 3-363 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	0.8	[767]
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3-364 Measure Life

Equipment	EUL	RUL	Ref
Recirculating Pump	15	5	[770]

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3.11.8 PIPE INSULATION

Market	Commercial/Multifamily
Baseline Condition	RF/DI
Baseline	Existing
End Use Subcategory	Insulation
Measure Last Reviewed	November 2022

Description

This measure covers the installation of fiberglass, rigid foam, and cellular glass pipe insulation on exposed and uninsulated metal or steel piping with a nominal diameter between 0.50" and 8.00" for hot water and steam type space heating and/or domestic hot water (DHW) distribution systems in commercial, industrial, and multifamily high-rise buildings. The measure is restricted to insulation of hot water distribution pipe in conditioned and unconditioned spaces. Space heating pipe insulation is limited to insulation installed in unheated spaces only. Insulation of CPVC, PEX, and HDPE piping is not eligible for savings under this measure due to low potential of savings.

In New Jersey, the current state energy code (ASHRAE 90.1 2019 in 2023) defines the energy code standards for buildings except low rise residential. Hence, this has been used to define default thermal efficiencies of heating systems. However, when it does not include service water heating provisions, it leaves federal equipment efficiency standards to define baseline.

This measure caters for all insulation types given that they are ASHRAE 90.1 2019 code compliant and are installed by certified professionals. The R-value of an insulation is the thermal resistance of its constituent material, which is derived by dividing the thickness of the material by the material's thermal conductivity, or k-value. Thermal transmittance, or the material's U-factor, is the inverse of the R-value.

Baseline Case

The baseline condition is bare copper (metal) or steel domestic hot water or space heating piping in an unconditioned space.

Efficient Case

An insulated pipe in an unconditioned spaced conforming to the requirements of ASHRAE 2019 Section 6.8.3, Table 3-1.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = \frac{\left[\left(\frac{UA}{L}\right)_b - \left(\frac{UA}{L}\right)_q\right] \times L \times \left(T_{pipe} - T_{amb}\right) \times hrs \times SF_{elec}}{Et_{elec} \times 3{,}412}$$

Annual Fuel Savings

$$\Delta Therms = \frac{\left[\left(\frac{UA}{L}\right)_b - \left(\frac{UA}{L}\right)_q\right] \times L \times \left(T_{pipe} - T_{amb}\right) \times hrs \times SF_{fuel}}{Et_{fuel} \times 100{,}000}$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{8{,}760} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-365 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{life}$	Lifetime fuel savings	Calculated	Therms	
L	Length of installed insulation	Site-specific	ft	
T_{pipe}	Average temperature of hot water or steam in distribution system piping	Site-specific, if unknown lookup in Table 3-370	°F	[775][776][779]
T_{amb}	Surrounding average ambient air temperature	Site-specific, if unknown: DHW: 70 Space Heat: 50	°F	[783]
Et_{fuel}	Recovery Efficiency of fuel water heaters or AFUE of boiler for space heating	Site-specific, if unknown: DHW[145]: 0.8 Space Heating Boilers: Lookup in Table 3-368	N/A	[780][781]
Et_{elec}	Recovery Efficiency of electric water heaters	Site-specific, if unknown: Non-Heat Pump DHW[146]: 0.98 Heat Pump DHW: Lookup in Table 3-369	N/A	[272][774]
hrs	Equivalent full load heating hours	Site-specific, if unknown: DHW: 8,760 Boilers: Lookup heating EFLH in Appendix C:	hrs	[207][207]

[145] The 80% default assumption comes from most ASHRAE 90.1 2019 minimum thermal efficiencies listed for water heater.
[146] ASHRAE 90.1 2019 does not list thermal efficiencies for electric water heaters. Instead it references UEF values for the respective classes. The 98% assumption comes from the Code of Federal regulations. The 98% default value should not be used for heat pump water heaters.

Variable	Description	Value	Units	Ref
		Heating and Cooling EFLH		
$(UA/L)_b$	Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from uninsulated pipe[147]	Lookup in Table 3-366	Btu/hr-°F-ft	[777]
$(UA/L)_q$	Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from insulated pipe[147]	Lookup in Table 2-186	Btu/hr-°F-ft	[785]
SF_{elec}	Adjustment to electric water heating energy savings when water heating fuel is unknown	Electric WH: 1.0 Unknown WH: 0.55	N/A	[778]
SF_{fuel}	Adjustment to fossil fuel water heating energy savings based on water heating fuel[f]	Fossil Fuel WH & Space Heating: 1.0 Unknown WH: 0.56	N/A	[778]
CF	Electric coincidence factor	Lookup in Table 3-133	N/A	
PDF	Gas peak day factor	Lookup in Table 3-133	N/A	
EUL	Effective useful life	See Measure Life section	Years	

Table 3-366 Product of Overall Heat Transfer Coefficient and Pipe Area per foot from Uninsulated Pipe $(UA/L)_b$

Nominal Pipe Size (in)	Bare Copper Piping			Bare Steel Piping	
	Domestic Hot Water	Hot Water Heat	Steam Heat	Hot Water Heat	Steam Heat
0.50	0.44	0.48	0.53	0.53	0.59
0.75	0.54	0.58	0.64	0.65	0.72
1.00	0.65	0.70	0.78	0.79	0.88
1.25	0.80	0.86	0.96	0.97	1.09
1.50	0.90	0.97	1.09	1.10	1.23
2.00	1.10	1.19	1.33	1.34	1.51
2.50	1.31	1.42	1.58	1.60	1.80
3.00	1.57	1.70	1.90	1.92	2.16
3.50	1.77	1.92	2.15	2.18	2.45
4.00	1.98	2.14	2.40	2.43	2.73

[147] Also called Building Load Coefficienct per unit length

Nominal Pipe Size (in)	Bare Copper Piping			Bare Steel Piping	
	Domestic Hot Water	Hot Water Heat	Steam Heat	Hot Water Heat	Steam Heat
5.00	2.41	2.61	2.92	2.97	3.34
6.00	2.84	3.07	3.45	3.50	3.94
8.00	3.64	3.94	4.42	4.50	5.06

Table 3-367 Product of Overall Heat Transfer Coefficient and Pipe Area per foot from Insulated Pipe $(UA/L)_q$

Nominal Pipe Size (in)	Fiberglass						Rigid Foam/Cellular Glass					
	0.5 in	1 in	1.5 in	2 in	2.5 in	3 in	0.5 in	1 in	1.5 in	2 in	2.5 in	3 in
0.50	0.13	0.09	0.08	0.07	0.06	0.06	0.15	0.12	0.10	0.09	0.09	0.08
0.75	0.14	0.11	0.09	0.08	0.07	0.07	0.17	0.13	0.11	0.10	0.10	0.09
1.00	0.17	0.12	0.10	0.09	0.08	0.07	0.19	0.15	0.13	0.12	0.11	0.10
1.25	0.20	0.14	0.11	0.10	0.09	0.08	0.23	0.17	0.15	0.13	0.12	0.11
1.50	0.22	0.15	0.12	0.11	0.10	0.09	0.25	0.19	0.16	0.14	0.13	0.12
2.00	0.26	0.18	0.14	0.12	0.11	0.10	0.29	0.22	0.18	0.16	0.14	0.13
2.50	0.30	0.20	0.16	0.14	0.12	0.11	0.34	0.25	0.20	0.18	0.16	0.15
3.00	0.35	0.24	0.18	0.16	0.14	0.12	0.39	0.29	0.23	0.20	0.18	0.16
3.50	0.40	0.26	0.20	0.17	0.15	0.13	0.44	0.32	0.26	0.22	0.20	0.18
4.00	0.44	0.29	0.22	0.18	0.16	0.14	0.48	0.35	0.28	0.24	0.21	0.19
5.00	0.52	0.34	0.26	0.22	0.19	0.17	0.58	0.41	0.33	0.28	0.25	0.22
6.00	0.61	0.39	0.30	0.25	0.21	0.19	0.67	0.47	0.37	0.32	0.28	0.25
8.00	0.77	0.49	0.37	0.30	0.26	0.23	0.84	0.59	0.46	0.39	0.34	0.30

Table 3-368 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements

Equipment Type	Subcategory or Rating Condition	Size Category (Input)	Efficiency as of 3/2/2022	Test Procedure
Boilers, hot water	Gas fired	<300,000 Btu/h	82% AFUE	10 CFR 430 Appendix N
		≥300,000 Btu/h and ≤2,500,000 Btu/h	80% Et	10 CFR 431.86
		>2,500,000 Btu/h	82% Ec	

Equipment Type	Subcategory or Rating Condition	Size Category (Input)	Efficiency as of 3/2/2022	Test Procedure
	Oil fired	<300,000 Btu/h	84% AFUE	10 CFR 430 Appendix N
		≥300,000 Btu/h and ≤2,500,000 Btu/h	82% Et	10 CFR 431.86
		>2,500,000 Btu/h	84% Ec	
Boilers, steam	Gas fired	<300,000 Btu/h	80% AFUE	10 CFR 430 Appendix N
	Gas fired—all, except natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79% Et	10 CFR 431.86
		>2,500,000 Btu/h	79% Et	
	Gas fired—natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79% Et	
		>2,500,000 Btu/h	79% Et	
	Oil fired	<300,000 Btu/h	82% AFUE	10 CFR 430 Appendix N
		≥300,000 Btu/h and ≤2,500,000 Btu/h	81% Et	10 CFR 431.86
		>2,500,000 Btu/h	81% Et	

Table 3-369 Default Heat Pump Water Heater COPs and UEF by Tank Storage Capacity

Size (Gallons)	UEF	Calculated COP
50	3.30	2.83
50	3.50	2.92
50	3.75	3.14
65	3.30	2.85
65	3.50	2.94
65	3.75	3.24
80	3.30	2.85
80	3.50	3.01
80	3.75	3.38
Unknown Size[148]	-	3.016

[148] Unknown COP is the average of storage tank heat pump water heater's COP for medium to high draw types covering a storage capacity range of 50 gallons to 80 gallons taken from California Energy Data and Reporting System's DEER Water Heater Calculator [774]

Table 3-370 Average Temperature of Hot Water or Steam in Distribution System Piping

System Type	Facility Type	Pipe Temperature °F
Hot Water	Commercial	138
Hot Water	Industrial	134
Low Pressure Steam[149]	C&I	240
Medium Pressure Steam	Commercial	304
Medium Pressure Steam	Industrial	258

Peak Factors

Table 3-371 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Electric DHW: 1.0 Hot Water: N/A	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 13 years for electric water heaters and 11 years for gas water heaters [786].

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3.12 PROCESS

3.12.1 VSD AIR COMPRESSORS

Market	Commercial and Industrial
Baseline Condition	TOS/NC
Baseline	Code
End Use Subcategory	Compressed Air
Measure Last Reviewed	December 2022

Description

Variable-Speed Drive (VSD) Air Compressors use a variable speed drive on the motor to match motor output to the load, resulting in greater efficiency than fixed-speed air compressors. Baseline compressors choke off inlet air to modulate the compressor output, resulting in increased energy consumption and peak demand. This measure relates to the installation of a new air compressor of 100 HP or less with a variable speed drive. Projects involving compressors larger than 100 HP should be treated as custom projects.

Baseline Case

The baseline condition is a typical load/unload compressor.

Efficient Case

A screw compressor with variable speed control on the motor to match output to the load.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

$$\Delta kWh = 0.9 \times HP \times Hrs \times (COMP_b - COMP_q)$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \text{N/A}$$

Calculation Parameters

Table 3-372 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
HP	Compressor motor nominal HP	Site-specific	hp	
$COMP_b$	Baseline compressor factor	Look up in Table 3-374	N/A	[789]
$COMP_q$	Installed compressor factor, actual	Site-specific, if unknown use 0.705	N/A	[787]
Hrs	Compressor total hours of operation	Site-specific, if unknown look up in Table 3-373	Hrs/yr	[787]
CF	Coincidence factor	Look up in Table 3-373	N/A	[787]
PDF	Gas peak demand factor	Look up in Table 3-375	N/A	
0.9	Compressor motor nominal hp to full load kW Conversion factor	0.9	N/A	[787]
EUL	Effective useful life of new unit	See Measure Life Section	Years	

Table 3-373 Compressor Total Hours of Operation and Coincidence Factors

Number of Shifts	Description	Annual Operating Hours	Coincidence Factor (CF)
Single shift	7 AM – 3 PM, weekdays, minus holidays and scheduled down time	1,976	0.59
2 - shift	7AM – 11 PM, weekdays, minus holidays and scheduled down time	3,952	0.95
3 - shift	24 hours per day, weekdays, minus holidays and scheduled down time	5,928	0.95
4 - shift	24 hours per day, 7 days a week minus holidays and scheduled down time	8,320	0.95

Table 3-374 Baseline Compressor Factor

Baseline Compressor	Compressor Factor $COMP_b$ (≤45 hp)	Compressor Factor $COMP_b$ (>45 hp)
Modulating w/ Blowdown	0.890	0.863
Load/No Load w/ 1 Gallon-of-storage/ CFM_{Max}	0.909	0.887
Load/No Load w/ 3 Gallon-of-storage/ CFM_{Max}	0.831	0.811
Load/No Load w/ 5 Gallon-of-storage/ CFM_{Max}	0.806	0.786

Peak Factors

Table 3-375 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Look up in Table 3-373	[787]
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 13 years [788].

References

[787] Mid Atlantic Technical Reference Manual Version 10.0, (2020), https://neep.org/mid-atlantic-technical-reference-manual-trm-v10 Compressor factors were developed using DOE part load data for different compressor control types as well as load profiles from 50 facilities employing air compressors less than or equal to 40 hp, as sourced from the Efficiency Vermont TRM. (The "variable speed drive" compressor factor has been adjusted up from the 0.675 presented in the analysis to 0.705 to account for the additional power draw of the VSD).

[788] California Public Utilities Commission EUL Table, version 027 (updated November 12, 2022). Accessed December 30, 2022. https://www.caetrm.com/shared-data/value-table/EUL/

[789] Compressor factors for ≤40 hp motors were developed using DOE part load data for different compressor control types as well as load profiles from 50 facilities employing air compressors less than or equal to 40 hp, as sourced from the Efficiency Vermont TRM. (The "variable speed drive" compressor factor has been adjusted up from the 0.675 presented in the analysis to 0.705 to account for the additional power draw of the VSD). Compressor factors for >50 hp motors were developed using DOE part-load data for different compressor control types as well as load profiles from 45 compressors and 20 facilities. This data comes from ComEd Custom and Insustrial Systems programs. The compressors were filtered to reflect only rotary screw compressors, between 50

and 200 hp, and operating a minimum of 4 hour per day, Additionally, compressors with clear and consistent baseload profiles were excluded from this analysis.

3.12.2 COMPRESSED AIR LEAK DETECTION

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Maintenance
Measure Last Reviewed	March 2023

Description

This measure presents energy savings associated with reducing compressed air losses through ultrasonic leak detection and the repair of compressed air leaks.

Baseline Case

Industrial compressed air system with suspected leaks.

Efficient Case

Compressed air system with identified and repaired leaks.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = N_{leaks} \times CFM_{leaks} \times Eff_{comp} \times Hrs \times F_{control}$$

Annual Fuel Savings

$$\Delta Therms = N/A$$

Peak Demand Savings

$$\Delta kW_{Peak} = \frac{\Delta kWh}{Hrs} \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = N/A$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-376 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
N_{leaks}	Number of leaks repaired	Site-specific	N/A	
Hrs	Hours of operation per year	Site-specific, if unknown use 6,240	Hrs/yr	[794]
CFM_{leak}	CFM loss per leak	Site-specific, look up in Table 3-377	CFM	[790]
Eff_{comp}	Compresser efficiency	Site-specific, if unknown look up in Table 3-378	kW/CFM	[791]
$F_{control}$	Control factor, percent kW divided by percent load	Look up in Table 3-379	N/A	[792]
CF	Electric coincidence factor	Look up in Table 3-133	N/A	[793]
PDF	Gas peak day factor	Look up in Table 3-133	N/A	
EUL	Effective useful life	See Measure Life section	Years	

Table 3-377 CFM per Leak Size and Compressed Air Pressure

Pressure (psig)	Orifice Diameter (inches)					
	1/64	1/32	1/16	1/8	1/4	3/8
70	0.29	1.16	4.66	18.62	74.4	167.8
80	0.32	1.26	5.24	20.76	83.1	187.2
90	0.36	1.46	5.72	23.1	92.0	206.6

Pressure (psig)	Orifice Diameter (inches)					
	1/64	1/32	1/16	1/8	1/4	3/8
100	0.40	1.55	6.31	25.22	100.9	227.0
125	0.48	1.94	7.66	30.65	122.2	275.5

Values should be multiplied by 0.97 for well-rounded orifices and by 0.61 for sharp orifices.

Table 3-378 Default Compressor Efficiencies

Compressor Type	Efficiency (kW/CFM)
Single-acting reciprocating air compressor	0.23
Double-acting reciprocating air compressor	0.155
Lubricant-injected rotary screw compressor	0.185
Lubricant-free rotary screw compressor	0.2
Centrifugal compressor	0.18
Average	0.19

Table 3-379 Efficiency Factors per Control Type

Control Type	$F_{control}$ (% kW / % load)
Reciprocating – on/off control	1.00
Reciprocating – load/unload	0.74
Screw – load/unload oil free	0.73
Screw – load/unload 1 gal/CFM	0.43
Screw – load/unload 3 gal/CFM	0.53
Screw – load/unload 5 gal/CFM	0.63
Screw – load/unload 10 gal/CFM	0.73
Screw – inlet modulation	0.30
Screw – inlet modulation w/unloading	0.30
Screw – variable displacement	0.60
Screw – variable speed drive	0.97

Peak Factors

Table 3-380 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	Calculate as: CF = (annual operating hours) / 8,760	
Natural gas peak day factor (PDF)	See Appendix G: Natural Gas Peak Day Factors	

Measure Life

The effective useful life (EUL) is 1 year. [795]

References

[790] NREL, Chapter 22: Compressed Air Evaluation Protocol. https://www.energystar.gov/sites/default/files/buildings/tools/compressed_air3.pdf

[791] Data from Compressed Air Challenge "Fundamentals of Compressed Air Systems" Pgs. 28-32

[792] NREL, Chapter 22: Compressed Air Evaluation Protocol, October 2017. Pg 16

[793] KEMA, New Jersey’s Clean Energy Program Energy Impact Evaluation and Protocol Review, July 10, 2009.

[794] This is based on 3 shifts per day, 5 days per week. This figure is supported by a survey of previous compressed air projects within Michigan and Ohio energy efficiency programs.

[795] One year measure life is based on typical recommendation of annual leak survey.

3.13 WHOLE BUILDING

3.13.1 COMBINED HEAT AND POWER

Market	Commercial
Baseline Condition	NC/RF
Baseline	Code/Existing
End Use Subcategory	HVAC
Measure Last Reviewed	March 2023

Description

This measure applies to the installation of Combined Heat and Power (CHP) System in a commercial setting, defined as a system that sequentially generates both electrical energy and useful thermal energy from one fuel source. Eligible systems include: powered by non-renewable or renewable fuel sources, gas internal combustion engine, gas combustion turbine, microturbine, steam turbine, and fuel cells.

The measurement of energy and savings for CHP systems is based primarily on the characteristics of the individual systems subject to the general principles set out below. The majority of the inputs used to estimate energy and demand impacts of CHP systems will be drawn from individual project applications.

The methodology presented in the measure is based on the National Renewable Energy Laboratory's Combined Heat and Power, The Uniform Methods Project: Methods for Determining Energy- Efficiency Savings for Specific Measures 632[796].If a CHP system cannot be evaluated using the methodology in this measure (due to complexity of the system or other factors), the project may be evaluated using a custom engineering analysis.

CHP systems typically use fossil fuels to generate electricity that displaces electric generation from other sources. Therefore, the electricity generated from a CHP system should not be reported as either electric energy savings or renewable energy generation. Exceptions may be made to this standard, such as CHP systems that use an absorption chiller to convert useful heat to cooling energy, and thus operates in the summer; or cases where the CHP system generates more electricity than consumed and is allowed to export electricity to the grid. Alternatively, electric generation and capacity from CHP systems should be reported as Distributed Generation (DG) separate from energy savings and renewable energy generation. However, any waste heat recaptured and utilized should be reported as energy savings as discussed below.

Baseline Case

If the CHP system is replacing or adding on to an existing HVAC system, the baseline is the site-specific existing equipment. If the CHP system uses an absorption chiller, the baseline equipment is assumed to be a code-compliant electric chiller. For new construction, the baseline scenario is a standalone (no power generation) code-compliant HVAC system of the same capacity and fuel as the CHP system.

Efficient Case

The efficient case is the installed CHP system, defined as a system that sequentially generates both electrical energy and useful thermal energy from one fuel source. Eligible systems include: powered by non-renewable or renewable fuel sources, gas internal combustion engine, gas combustion turbine, microturbine, steam turbine, and fuel cells with and without heat recovery.

Annual Energy Savings Algorithms

Note: The alogirithms presented below are simplified. Users should adopt a level of rigor that matches the program needs and available data. As long as the energy impacts are calculated in an equivalent manner, alternative methodologies such as conducting a site-specific hourly/daily analysis are acceptable.

Annual Electric Energy Savings

$$\Delta kW\text{h} = kWh_{Net} + kWh_{ChillerOffset}$$

Where,

$$kWh_{Net} = kWh_{Gross} - kWh_{Consumed}$$

$$kWh_{ChillerOffset} = kWh_{Net} \times UHRR_C \times COP \times \frac{Eff_{ElecChiller}}{12}\ (if\ CHP\ is\ driving\ an\ absorption\ chiller)$$

$$UHRR_c = \frac{UHR_c}{kWh_{Net}}$$

$$kWh_{ChillerOffset} = 0\ (if\ no\ absorption\ chiller\ is\ involved)$$

Annual Fuel Savings

$$\Delta Therms = \frac{Fuel_{Offset} - Fuel_{Consumed}}{100}$$

Where,

$$Fuel_{Offset} = \frac{kWh_{Net} \times UHRR_H}{Eff_{Boiler}}$$

$$Fuel_{Consumed} = \frac{kWh_{Gross}}{Eff_{NetElec}} \times 3.412$$

$$UHRR_h = \frac{UHR_h}{kWh_{Net}}$$

$$Eff_{NetElec} = \frac{\Delta kW\text{h} \times 3.412}{Fuel_{input}}$$

Annual Peak Demand Savings

Calculation of peak demand savings requires site-specific hourly analysis. See UMP: Section 3.1 Determining Electricity Impacts Pg 11 for more detail.

Daily Peak Fuel Savings

Calculation of peak fuel savings requires site-specific hourly analysis. See UMP: Section 3.2 Determining Fuel Impacts Pg 12 for more detail.

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-381 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
$\Delta Therms$	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Annual peak demand savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
$Fuel_{Offset}$	Reduction in fuel consumption that would have been used for heating that can be attributed to the CHP system	Calculated	kBtu	
$Fuel_{Consumed}$	Utility delivered fuel consumed by CHP system	Calculated	kBtu	
$Eff_{NetElec}$	Net electrical efficiency, a measure of how much of the energy in the fuel input is converted to net electricity	Calculated	N/A	
$UHRR_C$	Useful heat recovery rate for absorption chiller	Calculated	kBtu/kWh	
$UHRR_h$	Useful heat recovery rate associated with heating offset	Calculated	kBtu/kWh	

Variable	Description	Value	Units	Ref
$KWh_{ChillerOffset}$	Annual electrical energy offset from electrical chillers if heat from the CHP measure is driving an absorption chiller	Calculated	kWh/yr	
kWh_{gross}	Overall electricity generated by CHP System	Site-specific/engineering calculation	kWh/yr	
$kWh_{consumed}$	Annual electricity consumed by CHP system: parasitic losses due to fan and pump motors, dedicated HVAC system, and lighting	Site-specific; if unknown, assume 3% of kWh_{gross}	kWh/yr	
UHR_h	Useful heat recovered: heat that is expected to be recovered from CHP system, including any heat recovered for absorption chiller use and used on-site	Site-specific/engineering calculation	kBtu	
UHR_c	Useful heat recovered: heat that is used to drive an absorption chiller	Site-specific/engineering calculation	kBtu	
kWh_{Net}	Net electricity generation by CHP: overall electricity generated by CHP System minus annual electricity consumed by CHP system	Site-specific/engineering calculation	kWh/year	
$Fuel_{Input}$	Annual Fuel input to CHP system	Site-specific/engineering cacluation	kBtu	
COP	COP of absorption chiller	Site-specific	N/A	
$Eff_{ElecChiller}$	Efficiency of baseline electric chiller	Site-specific, use 0.65 if unknown	kW/ton	[798]
12	Conversion factor	12	kBtu/ton	
Eff_{Boiler}	Efficiency of boiler that would serve heating loads in absence of CHP system	Site-specific, use 0.8 if unknown	N/A	[771]
100	Conversion factor	100	kBtu/therm	
3.412	Conversion factor	3.412	kBtu/kWh	
EUL	Effective useful life	See Measure Life	Years	

Peak Factors

Peak factors should be analyzed on a site-specific basis.

Non-Energy Impacts

CHP systems will result in emissions reduction in addition to energy savings. The amount of air emission reductions resulting from the electricity savings at the system level is obtained by multiplying the electricity savings by the 2021 non-baseload emission factors obtained from the US EPA eGRID for the RFCE Region data [800].

Table 3-382 Electric Emission Factors

Emissions Product	Emission Reduction
CO2	1,357.3 lbs/MWh
NOX	0.949 lbs/MWh
SO2	0.866 lbs/MWh

The amount of air emission reductions resulting from the natural gas savings at the system level is obtained by multiplying the natural savings by factors obtained from the US EPA:

Table 3-383 Natural Gas Emission Factors

Emissions Product	Emission Reduction
CO2	11.7 lbs/MWh
NOX	0.0092 lbs/MWh

Emission factors may be updated by future BPU Orders addressing the New Jersey Cost Test and Decarbonization Pilot programs. Please consult the NJ BPU website for the most current information on emission factors.

Measure Life

The effective useful life (EUL) is 10 years [796].[150]

References

[796] Simons, George, Stephan Barsun, and Charles Kurnik. 2017. Chapter 23: Combined Heat and Power, The Uniform Methods Project: Methods for Determining Energy- Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68579. https://www.nrel.gov/docs/fy17osti/68579.pdf

[797] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-6, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[150] Please note that the UMP estimates a range of 10-25 years for typical CHP lifetime. This measure presents the conservative estimate of 10 years. Note that CHP measure lifetime is dependant on facility operations, fuel, and maintenance; there may be scenarios where a site-specific lifetime estimate is most appropriate.

[798] ASHRAE Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings. (ASHRAE, 2019), Table 6.8.1-3, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards

[799] Provided by the New Jersey Department of Environmental Protection, Office of Air and Energy Advisor, on May 25, 2018, Using Weighted Average of 2017 PJM On-Peak and Off-Peak annual data https://www.pjm.com/-/media/library/reports-notices/special-reports/20180315-2017-emissions-report.ashx

[800] US Environmental Protection Agency Emissions & Generation Resource Integrated Database (eGRID) Summary Tables 2021. Data viewer accessed 5-19-2023. https://www.epa.gov/egrid/data-explorer

3.13.2 NEW CONSTRUCTION

Market	Commercial/Multifamily
Baseline Condition	NC
Baseline	Code
End Use Category	Whole Building
Measure Last Reviewed	January 2023

Description

This measure addresses high performance commercial and industrial new building design and construction. High performance new construction projects must either perform whole building modeling per ASHRAE guidelines or follow requirements through nationally recognized programs, including US Green Building Council's Leadership in Energy and Environmental Design (LEED) V4.1 [801], Passive House Institute US [802][303] or Passive House [803]. Minimum energy performance requirements for all new construction projects are measured from IECC 2018/2021 or ASHRAE 90.1-2016/2019 energy code or industry standard practice baselines [806]. Therefore, all projects shall result in energy performance better than that required by the applicable ASHRAE code or standard practice, i.e., the applicable New Jersey energy codes or standard practice baselines approved at the time of permit.

High performance new construction projects in NJ may target varying levels of energy performance, from a bundled measure approach per ASHRAE 90.1-2019 Addendum AP [804] to simple DOE-2 based modeling (e.g., Slipstream's Sketchbox) to comprehensive modeling per ASHRAE 90.1-2016/2019 Appendix G [805]. Simulation software used for new construction projects must comply with ASHRAE Standard 140-2020 [807].

References

[801] LEED requirements
[802] Passive House Institute US requirements.
[803] Passive House Institute requirements
[804] ASHRAE Addendum AP
[805] ASHRAE 90.1-2016/2019 Appendix G
[806] Commercial New Construction Industry Standard Practice Analysis
[807] ASHRAE Standard 140-2020 Method Of Test For Evaluating Building Performance Simulation Software

3.13.3 OPERATOR TRAINING

Market	Commercial
Baseline Condition	RF
Baseline	Existing
End Use Subcategory	Behavior
Measure Last Reviewed	January 2023

Description

Building Operator Certification (BOC) is a training and certification program for commercial and public sector building operators. The training program teaches participants how to improve building comfort and efficiency by optimizing the building's systems. BOC provide participants with knowledge about system operations, proper maintenance practices, occupant communication, and occupant comfort. Participants realize energy savings by utilizing the knowledge gained to improve their building operations through O&M and capital measures.

Deemed savings for this measure represent a convergence of analyses results from multiple BOC program evaluations that estimated net savings and were developed per square foot of building area to account for building size diversity. All savings algorithms presented in this work paper are for net savings. Participants must complete a rigorous BOC course and can only claim savings for the facilities for which the individual taking the course is responsible.

Measure Requirements

Participants must complete either the BOC Level I or Level II course and obtain a certificate of completion to be eligible for savings. Eligible BOC must cover the following subject areas:

BOC Level 1:

- Efficient Operation of HVAC Systems
- Measuring and Benchmarking Energy
- Efficient Lighting Fundamentals
- HVAC Controls Fundamentals
- Indoor Environmental Quality
- Common Opportunities for Low-Cost Operational Improvement

BOC Level 2:

- Building Scoping and Operational Improvements
- Optimizing HVAC Controls for Energy Efficiency

- Introduction to Building Commissioning
- Water Efficiency for Building Operators
- Project Peer Exchange

The BOC course must include formal instruction (i.e., lectures), individual projects, and group exercises, bringing the total course time to at least 61 hours. Participants must obtain a training certificate of completion to be eligible for savings. Individuals who participate are not eligible for savings more than twice over the measure life, once for BOC Level I and another for BOC Level II. The entire floor area for any given building can only be used once over the measure life, and evaluators will verify attendees' participation year-over-year.

The savings factors for this measure were developed based on an examination of savings using a weighted average approach from several similar BOC programs. It is important to note that the savings information referenced is net. Therefore, this measure does not require the additional application of a net-to-gross ratio.

Note: In the event there are multiple participants who operate the same building (i.e. service address), or group of buildings, care should be taken to ensure that savings are not claimed for based on the same square footage for multiple participants.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

$$\Delta kWh = C_e \times Area$$

Annual Fuel Savings

$$\Delta Therms = C_g \times Area$$

Peak Demand Savings

$$\Delta kW_{Peak} = C_d \times Area/1000 \times CF$$

Daily Peak Fuel Savings

$$\Delta Therms_{Peak} = \Delta Therms \times PDF$$

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

$$\Delta kWh_{Life} = \Delta kWh \times EUL$$

Lifetime Fuel Savings

$$\Delta Therms_{Life} = \Delta Therms \times EUL$$

Calculation Parameters

Table 3-384 Calculation Parameters

Variable	Description	Value	Units	Ref
ΔkWh	Annual electric energy savings	Calculated	kWh/yr	
ΔTherms	Annual fuel savings	Calculated	Therms/yr	
ΔkW_{Peak}	Peak Demand Savings	Calculated	kW	
$\Delta Therms_{Peak}$	Daily peak fuel savings	Calculated	Therms/day	
ΔkWh_{Life}	Lifetime electric energy savings	Calculated	kWh	
$\Delta Therms_{Life}$	Lifetime fuel savings	Calculated	Therms	
C_e	Unit area kWh savings constant per participant	0.482	kWh/ft²/participant	[808]
Area	Building area operated by the participant	Site-specific	ft²	
C_g	Unit gas savings constant per participant	0.0145	Therms/ft²/participant	[809]
C_d	Unit demand savings constant per participant	0.039	W/ft²/participant	[809]
1,000	Conversion factor	1,000	W/kW	
CF	Electric coincidence factor	Look up in Table 3-385	N/A	
PDF	Gas peak day factor	Look up in Table 3-385	N/A	
EUL	Effective useful life	See Measure Life Section	Years	

Peak Factors

Table 3-385 Peak Factors

Peak Factor	Value	Ref
Electric coincidence factor (CF)	1	
Natural gas peak day factor (PDF)	N/A	

Measure Life

The effective useful life (EUL) is 9.2 years [810].

References

[808] Building Operator Certification, BOC Energy Savings Summary and FAQ available at 2020-BOC-Energy-Savings-FAQ_1.0.pdf (theboc.info)

[809] 2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0, Page 805

[810] The overall weighted average useful life for BOC savings are 1) Average measure life of capital measures from the ComEd CY2020 evaluation. 2) Useful Life for Custom Measure, Illinois TRM v10 for CY2022.

3.13.4 CUSTOM

Market	Commercial/Multifamily
Baseline Condition	TOS/NC/RF/EREP/ERET/DI
Baseline	Code/ISP/Existing/Dual
End Use Subcategory	Custom
Measure Last Reviewed	January 2023

Description

In addition to the typical measures for which savings algorithms have been developed, it is important to identify and address additional opportunities for energy savings. Custom measures can often provide significant energy savings and can be tailored to the specific needs of a building or facility. If necessary, the utilities may develop specific guidelines for frequent custom measures for use in reporting and contractor tracking. This will ensure that the custom measures are implemented correctly and consistently; and that the energy savings are accurately reported. Additionally, it is important to continuously monitor and evaluate the effectiveness of the custom measures implemented and make adjustments as needed.

To implement custom measures, it is necessary to develop individual calculations for each measure to determine the energy savings. These calculations should take into account factors such as the cost of implementation, the expected energy savings, and any potential changes in operations or maintenance. Once the calculations are complete, the project must be reviewed for reasonableness by either a third-party consulting engineer or a qualified in-house engineer. Before a full review of the project is started, the project package should first be checked for completeness and compliance with program eligibility rules. Once the project review is complete, savings can be reported based on these individual calculations.

Baseline

The project baseline depends on the baseline condition. For time of sale (TOS) and new construction (NC) measures, the baseline is the applicable equipment energy code or standard; or industry standard practice (ISP). For retrofit (RF), early replacement (EREP), early retirement (ER) and direct install (DI) measures, the baseline is the existing equipment. Early replacement and direct install projects replacing functioning equipment must use a dual baseline approach, where the existing equipment defines the first baseline and code or ISP defines the second baseline. In all cases, the baseline should be more efficient than the existing equipment; if the efficiency of the existing equipment exceeds code or ISP, the existing equipment baseline should also be used for the second baseline calculations. When existing functioning equipment is replaced and savings are based on early replacement, documentation of the existing equipment viability should be provided. Such documentation includes a customer affidavit affirming the viability of the equipment to function over its remaining useful life and a video or picture demonstrating the equipment in action. Trend logs, maintenance and repair records, and other evidence of existing equipment viability should be provided for larger projects.

Industry Standard Practice (ISP) shall take precedence over a code baseline when ISP can be established. Projects not subject to codes or standards shall define and document an ISP baseline as part of the project development package. ISP for specific custom projects can be established through interviews with equipment vendors or subject matter experts; or by examining similar equipment installation by customer in other facilities.

Efficient Case

The efficiency of the measure shall exceed the first (and if applicable the second) baseline efficiency, and a rationale for how the project saves energy shall be provided.

Energy Savings Algorithm

Energy and demand savings are calculated on a custom basis for each customer's specific situation. Savings are calculated as the difference between baseline energy usage/peak demand and the energy use/peak demand after implementation of the custom measure. Energy savings estimates should be calibrated against billing or metered data where possible to validate the model and test the reasonableness of energy savings. A project narrative description including system design diagrams should be provided to assist in the project review. Energy savings calculations vary according to the custom project requirements, but generally fall into the following classifications:[151]

Simple Engineering Equations

Custom engineering calculations may be developed to estimate energy savings. These may be presented as a series of simple engineering equations tailored to the custom project measure and process. The engineering calculations must be documented and spreadsheets used to calculate the savings must be provided with live calculations. The engineering analysis must be sufficiently documented to allow an independent calculation of the measure savings.

Bin Methods

One method for calculating energy savings for custom energy efficiency measures is through the use of weather based bin analysis. This method involves analyzing weather data and grouping it into "bins" based on temperature, humidity, and other environmental factors. The bin analysis presents the number hours a particular weather condition exists during the year. Note, bin data to not consider time of day; hours tabulated for each weather bin are disconnected in time. Bin analysis is generally not applicable to time dependent measures.

Simulation

Another method for calculating energy savings for custom energy efficiency measures is through the use of whole building modeling simulations. This approach involves creating a computer model of a building that takes into account factors such as the building's layout, construction materials, HVAC systems, lighting, and other equipment. The model is then used to simulate different scenarios and analyze the building's energy consumption under different conditions. This can be useful for identifying opportunities for energy savings and for evaluating the potential impact of different custom measures. For example, a whole building simulation can be used to analyze the impact of different lighting systems, insulation materials,

[151] See the California Evaluation Framework Chapters 6 and 7 for more information about engineering methods.

or window treatments on energy consumption. The simulation can also be used to analyze the impact of changes in occupancy, equipment usage, or other factors. Whole building modeling simulations can be a powerful tool for identifying and addressing opportunities for energy savings across a package of measures where significant measure interactions are expected.

Pre/Post Billing Analysis

Energy savings may be calculated through an analysis of whole building or submetered energy consumption before and after measure installation. The billing analysis should use a linear or multi-variate regression approach that normalizes the savings for differences in weather conditions, production and so on during the pre and post periods and also corrects for other non-routine conditions. The pre/post billing analysis should follow the International Measurement and Verification Protocol (IPMVP) Option C and/or ASHRAE Guideline 14. Open source software products compliant with IPMVP Option C or ASHRAE Guideline 14 such as OpenEEMeter are acceptable methods to evaluate energy savings under conditions where the energy consumption data can be fit to outdoor temperature or degree-day data and non-rountine events are not present or of insignificant magnitude.

Pre/Post Billing Analysis approaches are best suited for EREP, ERET and DI projects where an existing equipment baseline is appropriate. Pre/Post Billing Analysis approaches are not suitable for NC and TOS projects. When calculating lifetime savings, EREP, ERET and DI projects must adjust savings from an existing equipment baseline to an ISP baseline during the second baseline period.

Calculation Parameters

Energy savings calculations must identify the source of each parameter used in the analysis. Parameters that are uncertain should be identified as candidates for project specific measurement and verification (M&V).

Measurement and Verification

Projects where the input assumptions and savings estimates are uncertain may benefit from site specific measurement and verification (M&V). Project developers and reviewers should consider whether the project should include M&V as part of the project development process. For projects that include M&V, a site specific measurement and verification plan should be developed that documents measurement activities and their use in the energy savings analysis. Depending on the level of uncertainty, M&V may be conducted before measure installation (pre installation M&V) and/or after measure installation (post installation M&V). The International Measurement and Verification Protocol (IPMVP) and/or ASHRAE Guideline 14 should be referenced when developing an M&V plan. The M&V plans may follow IPMVP Option A (partially measured retrofit isolation), Option B (fully measure retrofit isolation) Option C (Whole building billing analysis) or Option D (Calibrated simulation) approaches.

Lifetime Energy Savings Algorithms

Lifetime energy savings for time of Sale (TOS) and new construction (NC) projects are calculated as the product of the first year kWh and/or therm savings and the measure effective useful life (EUL). Projects with multiple measures having different EULs shall use a savings weighted average EUL across all measures in the project.

Lifetime savings for early replacement (EREP), early retirement (ERET) and direct installation (DI) measures where functioning equipment is replaced must use a dual baseline approach. The first baseline savings considers the difference between the existing equipment consumption and the measure consumption for the remaining life (RUL) of the existing equipment. The second baseline savings considers the difference between code or standard practice equipment consumption and the measure consumption for the remaining life of the measure (EUL-RUL).

Peak Factors

The summer coincident peak demand savings shall be calculated consistent with the system peak definition presented in Chapter 1.

Measure Life

Measure life will be specific to each custom measure. For custom measures using technologies that are the same or similar to those addressed in other TRM measures, refer to those measures for measure lives. For measures not covered by the TRM, measure life assumptions shall be documented and justified in the project documentation package such as ASHRAE or manufacturer specifications. The EUL for retrofit (RF) measures shall be calculated as the smaller of the measure EUL or the host equipment remaining useful life (RUL). The overall project EUL shall be the savings weighted EUL of the measures included in the project.

References

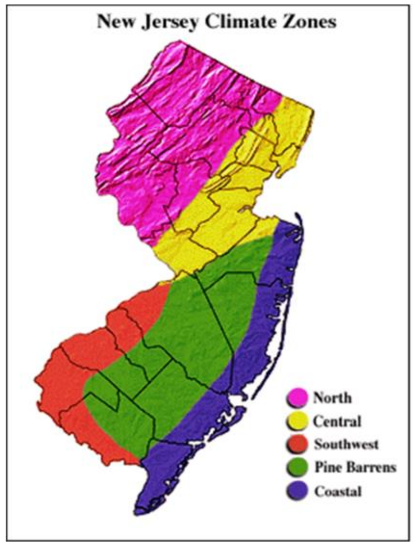
[811] California Evaluation Framework. Available at https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpuc_public_website/content/utilities_and_industries/energy/energy_programs/demand_side_management/ee_and_energy_savings_assist/caevaluationframework.pdf

[812] International Measurement and Verification Protocol (IPMVP) available at https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

[813] ASHRAE Guideline 14-2014. Available at https://webstore.ansi.org/standards/ashrae/ashraeguideline142014

4 APPENDIX A: CLIMATE ZONE DESCRIPTIONS

Weather-dependent parameters are presented by climate zone throughout the TRM when applicable. The Office of the State Climatologist divides the state into five climate regions as shown below.[152]



A representative city from the TMY3 long term average weather data set was assigned to each of the climate zones.[153] A population weight derived from 2020 Census data was assigned to each of the climate zones to compute a statewise average value as shown below.[154]

Table 4-1 Climate Zone Representative Cities and Weights

NJ Climate Division	Representative City	Population Weight
Northern Zone	Allentown, PA	0.17
Central Zone	Trenton, NJ	0.45
Pine Barrens Zone	McGuire Air Force Base, NJ	0.11
Southwest Zone	Philadelphia, PA	0.11
Coastal Zone	Atlantic City, NJ	0.16

Please note all utilities should use weighted average value for EFLH, as presented in Appendix C: . For other climate parameters, utilities may differentiate by climate zone or may default to the statewide average value.

[152] https://climate.rutgers.edu/stateclim/
[153] https://www.nrel.gov/docs/fy08osti/43156.pdf
[154] https://www.census.gov/library/stories/state-by-state/new-jersey-population-change-between-census-decade.html

5 APPENDIX B: BUILDING PROTOTYPE DESCRIPTIONS

Analysis used to develop heating and cooling equivalent full load hours is based on DOE-2.2 simulations of a set of prototypical small and large buildings. The prototypical simulation models were derived from the commercial building prototypes used in the California Database for Energy Efficiency Resources (DEER) study, with adjustments made for local building practices and climate.[155] The simulations were driven using Typical Meteorological Year (TMY3) long-term average weather data.[156]

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[155] 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December 2005. Available at www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf.

[156] See: Wilcox and Marion, "Users Manual for TMY3 Data Sets," NREL/TP-581-43156, National Renewable Energy Lab, May 2008. https://www.nrel.gov/docs/fy08osti/43156.pdf

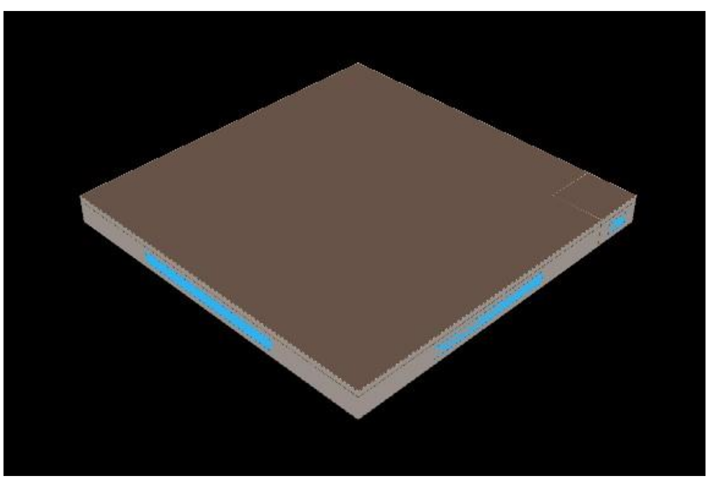
5.1 ASSEMBLY

A prototypical building energy simulation model for an assembly building was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

ASSEMBLY PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	34,000 square feet Auditorium: 33,240 SF Office: 760 SF
Number of floors	1
Wall construction and R-value	Concrete block, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Auditorium: 3.4 W/SF Office: 2.2 W/SF
Plug load density	Auditorium: 1.2 W/SF Office: 1.7 W/SF
Operating hours	Mon-Sun: 8am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	100 - 110 SF/ton depending on climate
Thermostat set points	Occupied hours: 76 ºF cooling, 72 ºF heating Unoccupied hours: 79 ºF cooling, 69 ºF heating

A computer-generated sketch of the Assembly Building prototype is shown below.



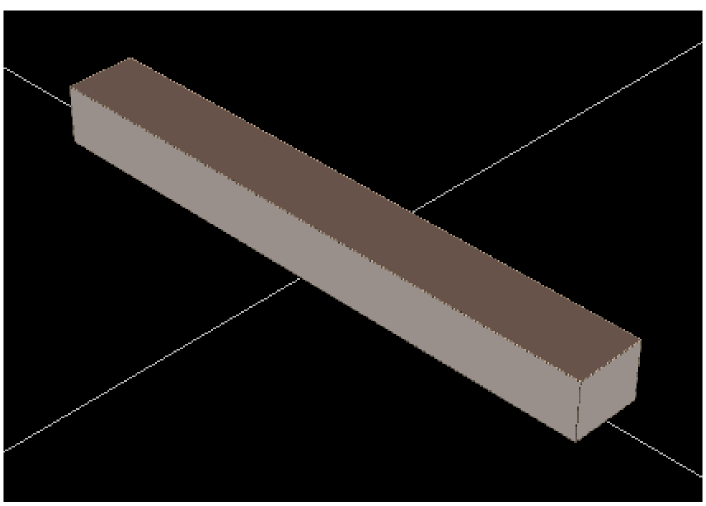
5.2 AUTO REPAIR

A prototypical building energy simulation model for an auto repair building was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

AUTO REPAIR PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	5150 square feet
Number of floors	1
Wall construction and R-value	Concrete block, R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13,5
Glazing type	Double pane clear; SHGC = ,74U-value = 0,72
Lighting power density	2.2 W/SF
Plug load density	1.2 W/SF
Operating hours	Mon-Sun: 9am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	280 SF/ton
Thermostat set points	Occupied hours: 76 ºF cooling, 72 ºF heating Unoccupied hours: 81 ºF cooling, 67 ºF heating

A computer-generated sketch of the Auto Repair Building prototype is shown below.



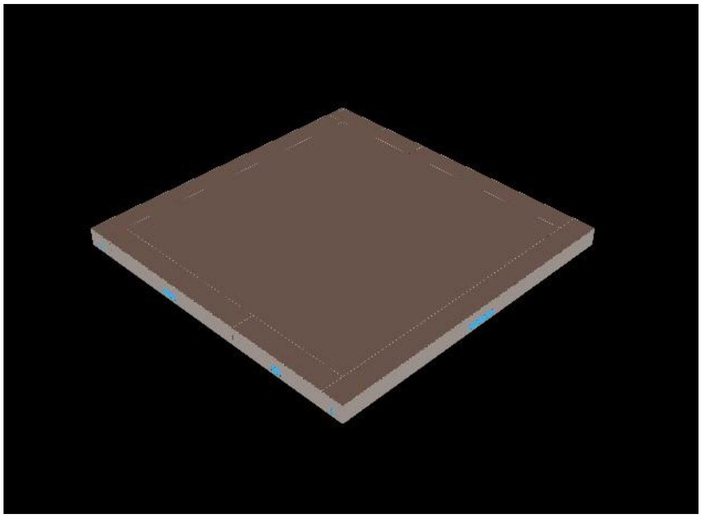
5.3 BIG BOX RETAIL

A prototypical building energy simulation model for a big box retail building was developedusing the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarizedbelow.

BIG BOX RETAIL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	130,500 square feet Sales: 107,339 SF Storage: 11,870 SF Office: 4,683 SF Auto repair: 5,151 SF Kitchen: 1,459 SF
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Metal frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Sales: 3.36 W/SF Storage: 0.88 W/SF Office: 2.2 W/SF Auto repair: 2.15 W/SF Kitchen: 4.3 W/SF
Plug load density	Sales: 1.15 W/SF Storage: 0.23 W/SF Office: 1.73 W/SF Auto repair: 1.15 W/SF Kitchen: 3.23 W/SF
Operating hours	Mon-Sun: 10am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	230 - 260 SF/ton depending on climate
Thermostat set points	Occupied hours: 76 °F cooling, 72 °F heating Unoccupied hours: 79 °F cooling, 69 °F heating

A computer-generated sketch of the Big Box Building prototype is shown below.



5.4 COMMUNITY COLLEGE

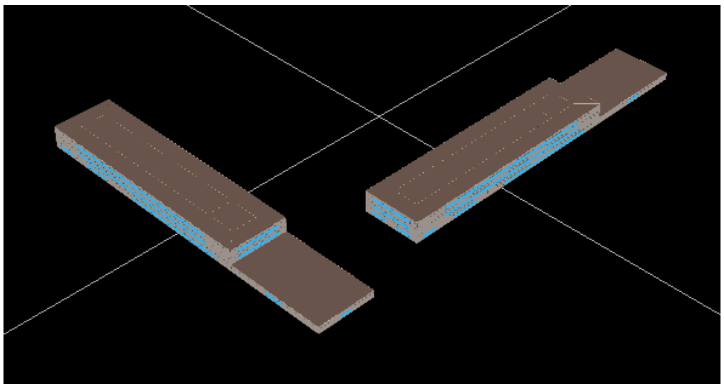
A prototypical building energy simulation model for a community college was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The model is really two identical buildings oriented 90 degreesapart. The characteristics of the prototype are summarized below.

Community College Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2 buildings, 150,000 square feet each; oriented 90º from each other Classroom: 150,825 SF Computer room: 9,625 SF Dining area: 26,250 SF Kitchen: 5,625 SF Office: 70,175 SF Total: 300,000 SF
Number of floors	3
Wall construction and R-value	CMU with brick veneer, plus R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Double pane clear, SHGC = 0.73; U-value = 0,72
Lighting power density	Classroom: 3.6 W/SF Computer room: 3.6 W/SF Dining area: 1.5 W/SF Gymnasium: 1.8 W/SF Kitchen: 3.6 W/SF
Plug load density	Classroom: 1.1 W/SF Computer room: 5.5 W/SF Dining area: 0.6 W/SF Gymnasium: 0.6 W/SF Kitchen: 3.3 W/SF
Operating hours	Mon-Fri: 8am – 7pm Sat: 8am – 4pm Sun: closed
HVAC system type	Combination PSZ and built-up with screw chiller and hot water boiler.
HVAC system size	250 SF/ton
Thermostat set points	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating
Chiller type	Water cooled and air cooled
Chilled water system type	Variable volume with 2 way control valves
Chilled water system control	Constant CHW Temp, 45 ºF set point
Boiler type	Hot water, 80% efficiency
Hot water system type	Variable volume with 2 way control valves,
Hot water system control	Constant HW Temp, 180 ºF set point

Each set of measures was run using each of three different HVAC system configurations: a constant volume reheat system without economizer, a constant volume reheat system with economizer, and a VAV system with economizer. The constant volume reheat system without economizer represents a system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. This presents a range of system loads and energy savings.

A computer-generated sketch of the Community College Building prototype is shown below.



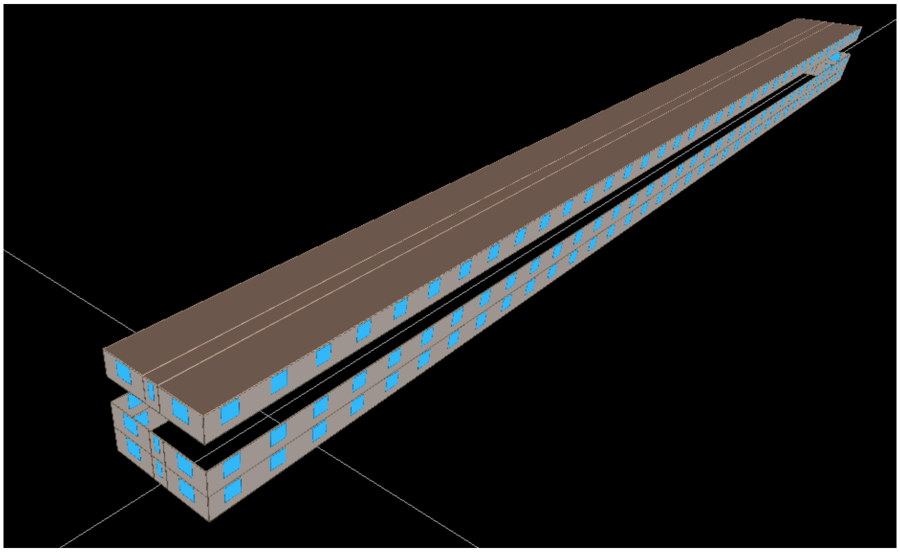
5.5 DORMITORY

A prototypical building energy simulation model for a university dormitory was developed usingthe DOE-2.2 building energy simulation program. The dormitory building was extracted from the DEER university prototype and modeled separately. The model consists of two identical buildings oriented 90 degrees apart. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

DORMITORY PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	170,000 square feet
Number of floors	4
Wall construction and R-value	CMU with R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Double pane clear; SHGC = 0.73; U-value = 0.72
Lighting power density	Rooms: 0.5 W/SF Corridors and common space: 0.8 W/SF
Plug load density	Rooms: 0.6 W/SF Corridors and common space: 0.2 W/SF
Operating hours	24/7 – 365 days
HVAC system type	Fan coils with centrifugal chiller and hot water boiler
HVAC system size	800 SF/ton
Thermostat set points	Daytime hours: 76 °F cooling, 72 °F heating Night setback hours: 81 °F cooling, 67 °F heating

A computer-generated sketch of the Dormitory Building prototype is shown below.



Note: The middle floors, since they thermally equivalent, are simulated as a single floor, and theresults are multiplied by 2 to represent the energy consumption of the 2 middle floors.

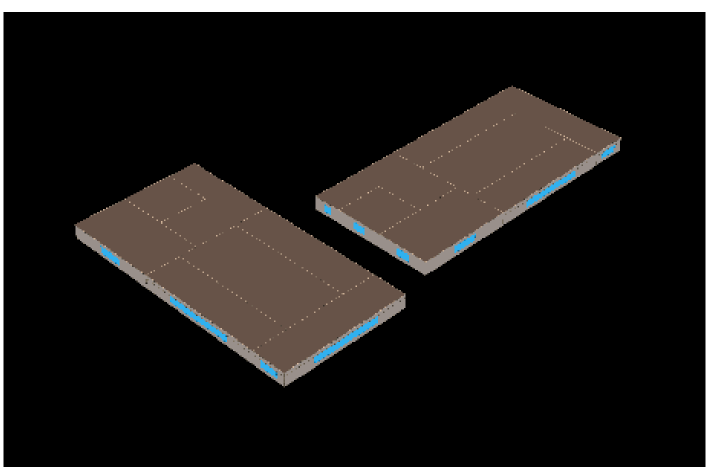
5.6 ELEMENTARY SCHOOL

A prototypical building energy simulation model for an elementary school was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The model is really of two identical buildings oriented in two different directions. The characteristics of the prototype are summarized below.

ELEMENTARY SCHOOL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2 buildings, 25,000 square feet each; oriented 90º from each other Classroom: 15,750 SF Cafeteria: 3,750 SF Gymnasium: 3,750 SF Kitchen: 1,750 SF
Number of floors	1
Wall construction and R-value	Wood frame with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Classroom: 4.4 W/SF Cafeteria: 1.7 W/SF Gymnasium: 2.1 W/SF Kitchen: 4.3 W/SF
Plug load density	Classroom: 1.2 W/SF Cafeteria: 0.6 W/SF Gymnasium: 0.6 W/SF Kitchen: 4.2 W/SF
Operating hours	Mon-Fri: 8am – 6pm Sun: 8am – 4pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	160 - 180 SF/ton depending on climate
Thermostat set points	Occupied hours: 76 ºF cooling, 72 ºF heating Unoccupied hours: 79 ºF cooling, 69 ºF heating

A computer-generated sketch of the Elementary School Building prototype is shown below.



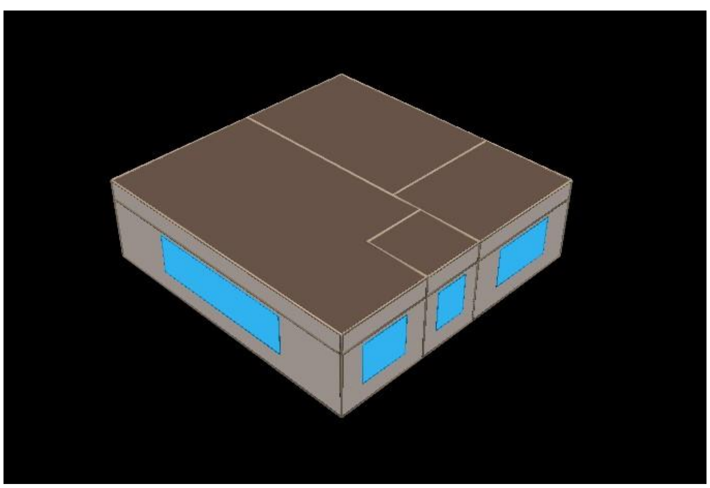
5.7 FAST FOOD RESTAURANT

A prototypical building energy simulation model for a fast food restaurant was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

FAST FOOD RESTAURANT PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2000 square feet 1,000 SF dining 600 SF entry/lobby 300 SF kitchen 100 SF restroom
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-5
Roof construction and R-value	Concrete deck with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	1.7 W/SF dining 2.5 W/SF entry/lobby 4.3 W/SF kitchen 1.0 W/SF restroom
Plug load density	0.6 W/SF dining 0.6 W/SF entry/lobby 4.3 W/SF kitchen 0.2 W/SF restroom
Operating hours	Mon-Sun: 6am – 11pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	100 – 120 SF/ton depending on climate
Thermostat set points	Occupied hours: 77 °F cooling, 72 °F heating Unoccupied hours: 80 °F cooling, 69 °F heating

A computer-generated sketch of the Fast Food Building prototype is shown below.



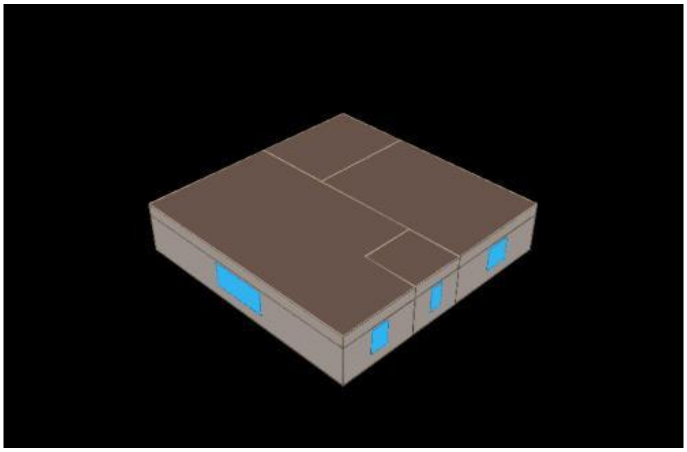
5.8 FULL-SERVICE RESTAURANT

A prototypical building energy simulation model for a full-service restaurant was developedusing the DOE-2.2 building energy simulation program. The simulations were driven usingTMY3 long-term average weather data. The characteristics of the full service restaurant prototype are summarized below.

FULL SERVICE RESTAURANT PROTOTYPE DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2000 square foot dining area 600 square foot entry/reception area 1200 square foot kitchen 200 square foot restrooms
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Dining area: 1.7 W/SF Entry area: 2.5 W/SF Kitchen: 4.3 W/SF Restrooms: 1.0 W/SF
Plug load density	Dining area: 0.6 W/SF Entry area: 0.6 W/SF Kitchen: 3.1 W/SF Restrooms: 0.2 W/SF
Operating hours	9am – 12am
HVAC system type	Packaged single zone, no economizer
HVAC system size	140 – 160 SF/ton depending on climate
Thermostat set points	Occupied hours: 77 ^{o}F cooling, 72 ^{o}F heating Unoccupied hours: 80 ^{o}F cooling, 69 ^{o}F heating

A computer-generated sketch of the Full-Service Restaurant Building prototype is shown below.



5.9 GROCERY

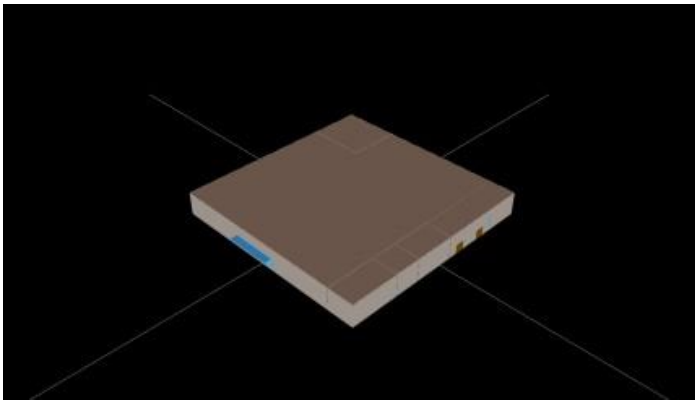
A prototypical building energy simulation model for a grocery building was developed using theDOE-2.2R[157] building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

GROCERY PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	50,000 square feet Sales: 40,000 SF Office and employee lounge: 3,500 SF Dry storage: 2,860 SF 50ºF prep area: 1,268 SF 35ºF walk-in cooler: 1,560 SF - 5ºF walk-in freezer: 812 SF
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Metal frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Sales: 3.36 W/SF Office: 2.2 W/SF Storage: 1.82 W/SF 50ºF prep area: 4.3 W/SF 35ºF walk-in cooler: 0.9 W/SF - 5ºF walk-in freezer: 0.9 W/SF
Equipment power density	Sales: 1.15 W/SF Office: 1.73 W/SF Storage: 0.23 W/SF 50ºF prep area: 0.23 W/SF + 36 kBTU/h process load 35ºF walk-in cooler: 0.23 W/SF + 17 kBTU/h process load - 5ºF walk-in freezer: 0.23 W/SF+ 29 kBTU/h process load
Operating hours	Mon-Sun: 6am – 10pm
HVAC system type	Packaged single zone, no economizer
Refrigeration system type	Air cooled multiplex
Refrigeration system size	Low temperature (-20ºF suction temp): 23 compressor ton Medium temperature (18ºF suction temp): 45 compressor ton
Refrigeration condenser size	Low temperature: 535 kBTU/h THR Medium temperature: 756 kBTU/h THR
Thermostat set points	Occupied hours: 74ºF cooling, 70ºF heating Unoccupied hours: 79ºF cooling, 65ºF heating

[157] DOE-2.2R is a specialized version of the DOE-2.2 program, designed specifically to model refrigeration systems.

A computer-generated sketch of the Grocery Building prototype is shown below.



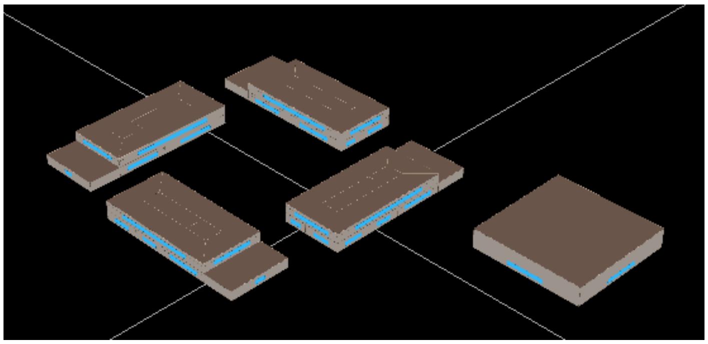
5.10 HIGH SCHOOL

A prototypical building energy simulation model for a high school was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The model is really of four identical buildings oriented in four different directions, with a common gymnasium. The characteristics of the prototype are summarized below.

HIGH SCHOOL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	4 buildings, 25,000 square feet each; oriented 90º from each other Classroom: 88,200 SF Computer room: 3,082 SF Dining area: 22,500 SF Gymnasium: 22,500 SF Kitchen: 10,500 SF Office: 3,218 SF Total: 150,000 SF
Number of floors	2
Wall construction and R-value	CMU with brick veneer, plus R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Double pane clear, SHGC = 0.73; U-value = 0,72
Lighting power density	Classroom: 3.6 W/SF Computer room: 3.6 W/SF Dining area: 1.5 W/SF Gymnasium: 1.8 W/SF Kitchen: 3.6 W/SF
Plug load density	Classroom: 1.1 W/SF Computer room: 5.5 W/SF Dining area: 0.6 W/SF Gymnasium: 0.6 W/SF Kitchen: 3.3 W/SF
Operating hours	Mon-Fri: 8am – 7pm Sat: 8am – 4pm Sun: closed
HVAC system type	Combination PSZ and built-up with screw chiller and hot waterboiler.
HVAC system size	250 SF/ton
Thermostat set points	Occupied hours: 76ºF cooling, 72ºF heating Unoccupied hours: 81ºF cooling, 67ºF heating

A computer-generated sketch of the High School Building prototype is shown below.



5.11 HOSPITAL

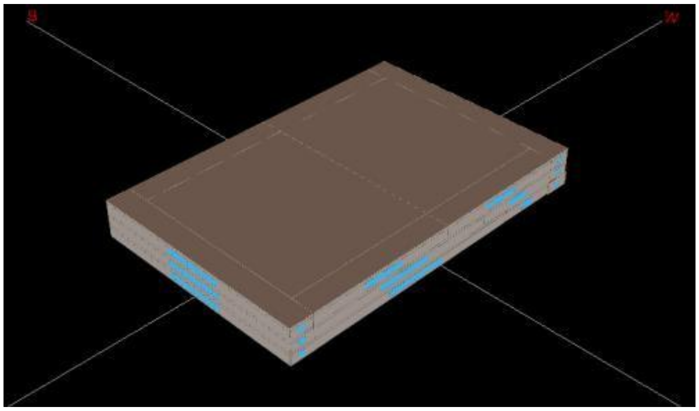
A prototypical building energy simulation model for a large hospital building was developedusing the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarizedbelow.

LARGE HOSPITAL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	250,000 square feet
Number of floors	3
Wall construction and R-value	Brick and CMU, R=7.5
Roof construction and R-value	Built-up roof, R-13.5
Glazing type	Multi-pane; Shading-coefficient = 0.84; U-value = 0.72
Lighting power density	Patient rooms: 2.3 W/SF Office: 2.2 W/SF Lab: 4.4 W/SF Dining: 1.7 W/SF Kitchen and food prep: 4.3 W/SF
Plug load density	Patient rooms: 1.7 W/SF Office: 1.7 W/SF Lab: 1.7 W/SF Dining: 0.6 W/SF Kitchen and food prep: 4.6 W/SF
Operating hours	24/7, 365
HVAC system types	Patient Rooms: 4 pipe fan coil Kitchen: Rooftop DX Remaining space; 1. Central constant volume system with hydronic reheat, without economizer; 2. Central constant volume system with hydronic reheat, with economizer; 3. Central VAV system with hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizingassumed.
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3 way control valves
Chilled water system control	Constant CHW Temp, 45 ºF set point
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3 way control valves
Hot water system control	Constant HW Temp, 180ºF set point
Thermostat set points	Occupied hours: 76ºF cooling, 72 ºF heating Unoccupied hours: 79 ºF cooling, 69 ºF heating

Each set of measures was run using each of three different HVAC system configurations: a constant volume reheat system without economizer, a constant volume reheat system with economizer, and a VAV system with economizer. The constant volume reheat system without economizer represents a system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. Thispresents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the Large Hospital Building prototype is shown below.



5.12 HOTEL

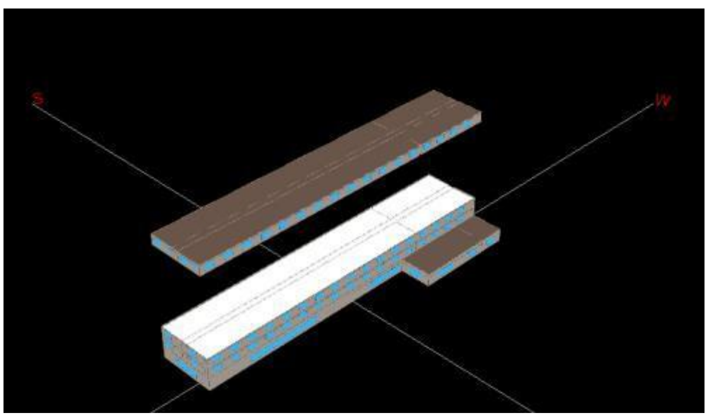
A prototypical building energy simulation model for a hotel building was developed using theDOE-2.2 building energy simulation program. The characteristics of the prototype are summarized below.

HOTEL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	200,000 square feet total Bar, cocktail lounge – 800 SF Corridor – 20,100 SF Dining Area – 1,250 SF Guest rooms – 160,680 SF Kitchen – 750 SF Laundry – 4,100 SF Lobby – 8,220 SF Office – 4,100 SF
Number of floors	11
Wall construction and R-value	Block construction, R-7.5
Roof construction and R-value	Wood deck with built-up roof, R-13.5
Glazing type	Multi-pane; Shading-coefficient = 0.84 U-value = 0.72
Lighting power density	Bar, cocktail lounge – 1.7 W/SF Corridor – 1.0 W/SF Dining Area – 1.7 W/SF Guest rooms – 0.6 W/SF Kitchen – 4.3 W/SF Laundry – 1.8 W/SF Lobby – 3.1 W/SF Office – 2.2 W/SF
Plug load density	Bar, cocktail lounge – 1.2 W/SF Corridor – 0.2 W/SF Dining Area – 0.6 W/SF Guest rooms – 0.6 W/SF Kitchen – 3.0 W/SF Laundry – 3.5 W/SF Lobby – 0.6 W/SF Office – 1.7 W/SF
Operating hours	Rooms: 60% occupied, 40% unoccupied All others: 24 hr / day
HVAC system type	Central built-up system: All except corridors and rooms 1. Central constant volume system with perimeter hydronic reheat, without economizer; 2. Central constant volume system with perimeter hydronic reheat, with economizer; 3. Central VAV system with perimeter hydronic reheat, with economizer PTAC (Packaged Terminal Air Conditioner): Guest rooms PSZ: Corridors

Characteristic	Value
HVAC system sizeM	Based on ASHRAE design day conditions, 10% over-sizing assumed
Minimum outdoor air fraction	Built up system 0.3; PSZ: 0.14; PTAC: 0.11 is typical
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3 way control valves
Chilled water system control	Constant CHW Temp, 45 °F set point
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3 way control valves
Hot water system control	Constant HW Temp, 180 °F set point
Thermostat set points	Occupied hours: 76 °F cooling, 72 °F heating Unoccupied hours: 81 °F cooling, 67 °F heating

A computer-generated sketch of the Hotel Building prototype is shown below.



5.13 LARGE OFFICE

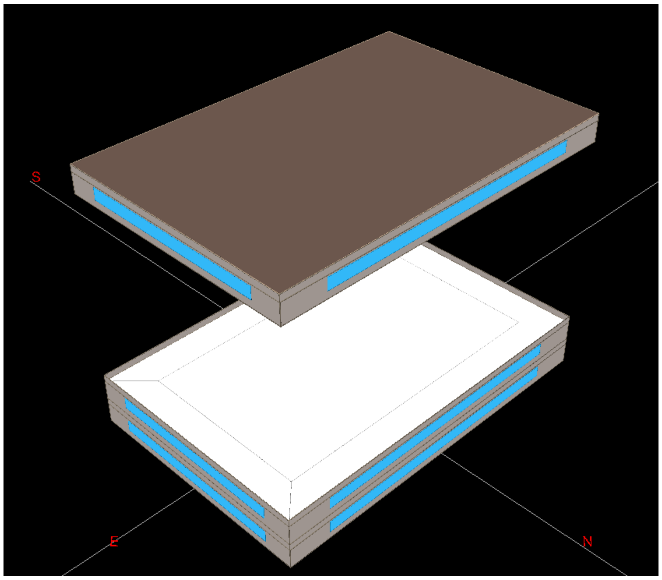
A prototypical building energy simulation model for a large office building was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

LARGE OFFICE PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	350,000 square feet
Number of floors	10
Wall construction and R-value	Glass curtain wall, R-7.5
Roof construction and R-value	Built-up roof, R-13.5
Glazing type	Multi-pane; Shading-coefficient = 0.84; U-value = 0.72
Lighting power density	Perimeter offices: 1.55 W/SF Core offices: 1.45 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system types	1. Central constant volume system with hydronic reheat, without economizer; 2. Central constant volume system with hydronic reheat, with economizer; 3. Central VAV system with hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3 way control valves
Chilled water system control	Constant CHW Temp, 45 °F set point
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3 way control valves
Hot water system control	Constant HW Temp, 180 °F set point
Thermostat set points	Occupied hours: 75 °F cooling, 70 °F heating Unoccupied hours: 78 °F cooling, 67 °F heating

Each set of measures was run using each of three different HVAC system configurations: a constant volume reheat system without economizer, a constant volume reheat system with economizer, and a VAV system with economizer. The constant volume reheat system without economizer represents a system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. Thispresents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the Large Office Building prototype is shown below.



Note: The middle floors, since they thermally equivalent, are simulated as a single floor, and theresults are multiplied by 8 to represent the energy consumption of the eight middle floors.

5.14 LARGE RETAIL

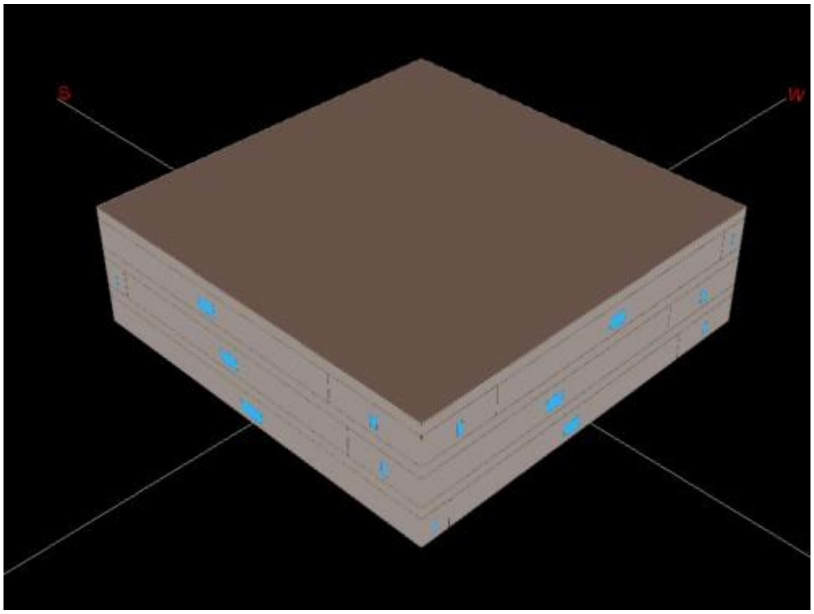
A prototypical building energy simulation model for a large retail building was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

LARGE RETAIL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	130,000 square feet Sales area: 96,000 SF Storage: 18,000 SF Office: 6,000 SF
Number of floors	3
Wall construction and R-value	Brick and CMU with R-7.5
Roof construction and R-value	Built-up roof, R-13.5
Glazing type	Multi-pane; SHGC= 0.73; U-value = 0.72
Lighting power density	Sales area: 2.8 W/SF Storage: 0.8 W/SF Office: 1.8 W/SF
Plug load density	Sales area: 1.1 W/SF Storage: 0.2 W/SF Office: 1.7 W/SF
Operating hours	Mon-Sat: 9am – 10pm Sun: 9am – 7pm
HVAC system types	1. Central constant volume system with hydronic reheat, without economizer; 2. Central constant volume system with hydronic reheat, with economizer; 3. Central VAV system with hydronic reheat, with economizer
HVAC system size	340 SF/ton
Chiller type	Water cooled and air cooled
Chilled water system type	Variable volume with 2 way control valves
Chilled water system control	Constant CHW Temp, 45 ºF set point
Boiler type	Hot water, 80% efficiency
Hot water system type	Variable volume with 2 way control valves
Hot water system control	Constant HW Temp, 180 ºF set point
Thermostat set points	Occupied hours: 76 ºF cooling, 72 ºF heating Unoccupied hours: 81 ºF cooling, 67 ºF heating

Each set of measures was run using each of three different HVAC system configurations: a constant volume reheat system without economizer, a constant volume reheat system with economizer, and a VAV system with economizer. The constant volume reheat system without economizer represents a system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. Thispresents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the Large Retail Building prototype is shown below.



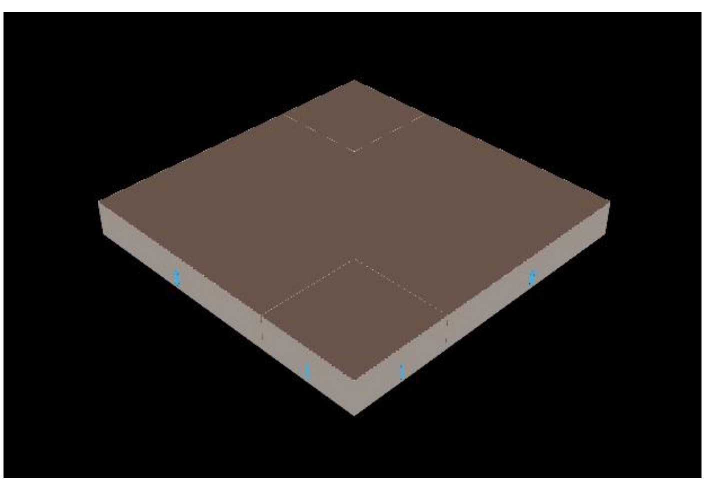
5.15 LIGHT INDUSTRIAL

A prototypical building energy simulation model for a light industrial building was developedusing the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

LIGHT INDUSTRIAL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	100,000 square feet total 80,000 SF factory 20,000 SF warehouse
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Concrete deck with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Factory – 2.1 W/SF Warehouse – 0.9 W/SF
Plug load density	Factory – 1.2 W/SF Warehouse – 0.2 W/SF
Operating hours	Mon-Fri: 6am – 6pm Sat Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	500 - 560 SF/ton depending on climate
Thermostat set points	Occupied hours: 78 cooling, 70 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the Light Industrial Building prototype is shown below.



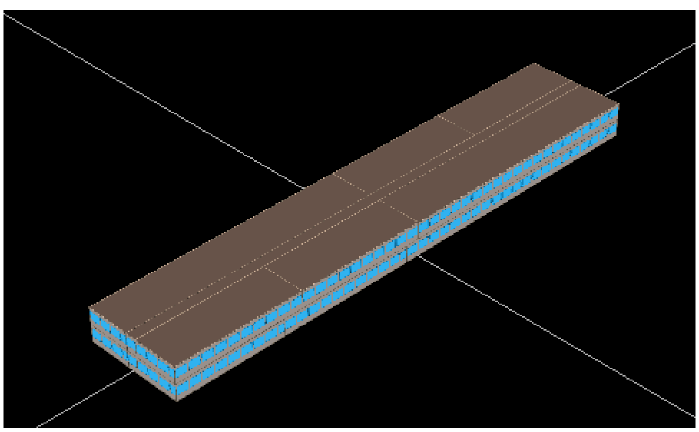
5.16 MOTEL

A prototypical building energy simulation model for a motel was developed using the DOE-2.2building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

MOTEL PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	30,000 square feet
Number of floors	2
Wall construction and R-value	Frame with R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear; SHGC = .87 U-value = 1.2
Lighting power density	0.6 W/SF
Plug load density	0.6 W/SF
Operating hours	24/7 - 365
HVAC system type	PTAC with electric heat
HVAC system size	540 SF/ton
Thermostat set points	Daytime hours: 76^{o}F cooling, 72 ^{o}F heating Night setback hours: 81 ^{o}F cooling, 67 ^{o}F heating

A computer-generated sketch of the Motel Building prototype is shown below.



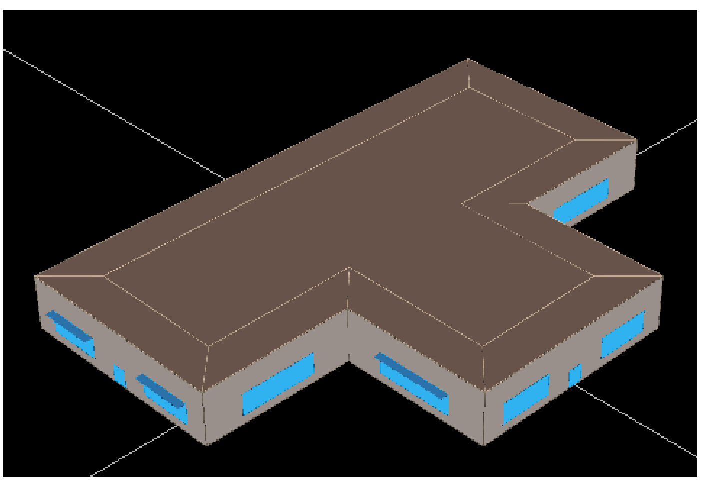
5.17 RELIGIOUS

A prototypical building energy simulation model for a religious worship building was developedusing the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized below.

RELIGIOUS WORSHIP PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	11,000 square feet
Number of floors	1
Wall construction and R-value	Brick with R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear; SHGC = .87, U-value = 1.2
Lighting power density	1.7 W/SF
Plug load density	1.2 W/SF
Operating hours	Mon-Sat: 12pm-6pm Sun: 9am-7pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	250 SF/ton
Thermostat set points	Occupied hours: 76ºF cooling, 70ºF heating Unoccupied hours: 82ºF cooling, 64ºF heating

A computer-generated sketch of the Religious Building prototype is shown below.



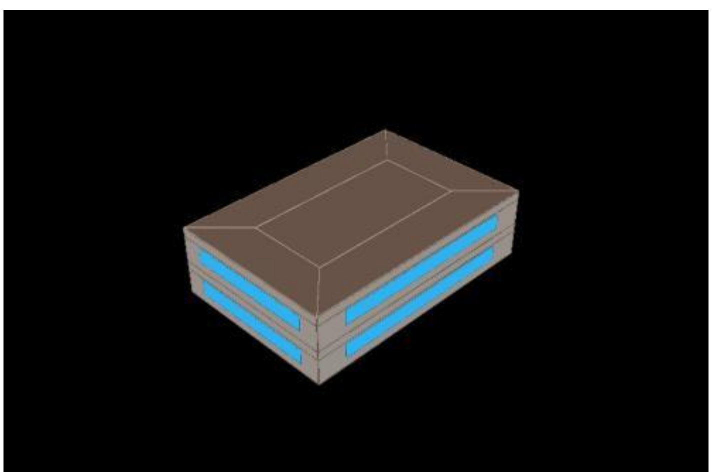
5.18 SMALL OFFICE

A prototypical building energy simulation model for a small office was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the small office prototype are summarized below.

SMALL OFFICE PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	**Existing (1970s) vintage**
Size	10,000 square feet
Number of floors	2
Wall construction and R-value	Wood frame with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Perimeter offices: 2.2 W/SF Core offices: 1.5 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	230 - 245 SF/ton depending on climate
Thermostat set points	Occupied hours: 76 °F cooling, 72 °F heating Unoccupied hours: 79 °F cooling, 69 °F heating

A computer-generated sketch of the Small Office Building prototype is shown below.



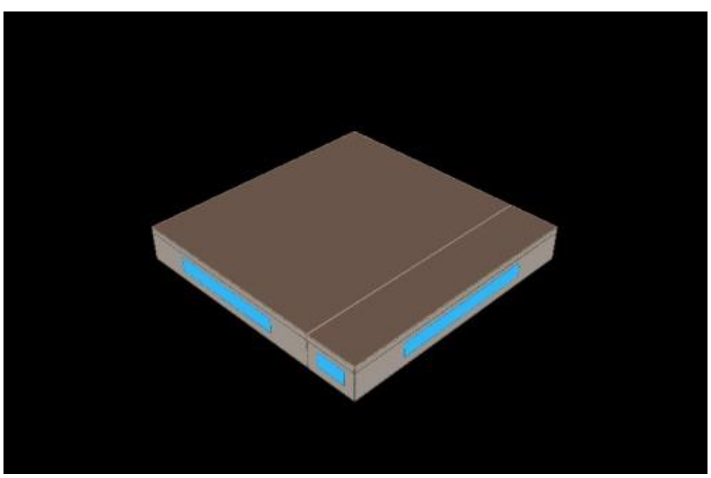
5.19 SMALL RETAIL

A prototypical building energy simulation model for a small retail building was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the small retail building prototype are summarized below.

SMALL RETAIL PROTOTYPE DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	Sales Area: 6400 SF Storage Area:1600 SF Total: 8000 SF
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Sales area: 3.4 W/SF Storage area: 0.9 W/SF
Plug load density	Sales area: 1.2 W/SF Storage area: 0.2 W/SF
Operating hours	Mon-Sat: 10 – 10 Sun: 10 – 8
HVAC system type	Packaged single zone, no economizer
HVAC system size	230 – 250 SF/ton depending on climate
Thermostat set points	Occupied hours: 76 ^{o}F cooling, 72 ^{o}F heating Unoccupied hours: 79 ^{o}F cooling, 69 ^{o}F heating

A computer-generated sketch of the Small Retail Building prototype is shown below.



5.20 UNIVERSITY

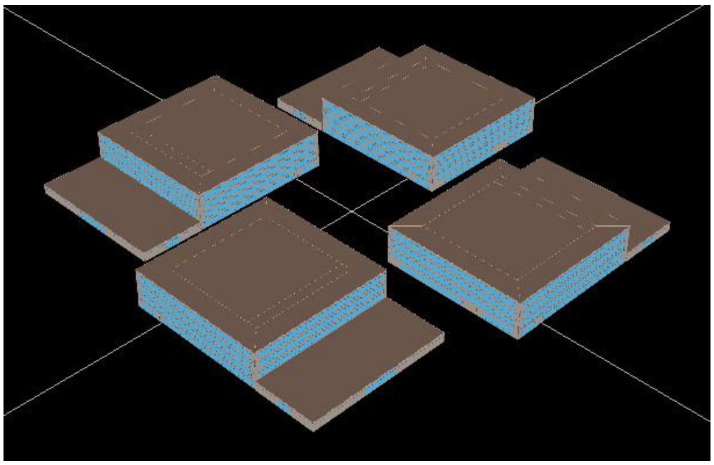
A prototypical building energy simulation model for a university building was developed usingthe DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The model is really four identical buildings oriented 90 degrees apart. The characteristics of the prototype are summarized below.

UNIVERSITY PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	4 buildings, 200,000 square feet each; oriented 90º from each other Classroom: 431,160 SF Computer room: 27,540 SF Dining area: 24,000 SF Kitchen: 10,500 SF Office: 226,800 SF Total: 800,000 SF
Number of floors	4
Wall construction and R-value	Insulated frame wall with R-7.5
Roof construction and R-value	Wood frame with built-up roof, R-13.5
Glazing type	Double pane clear, SHGC = 0.73; U-value = 0,72
Lighting power density	Classroom: 3.6 W/SF Computer room: 3.6 W/SF Dining area: 1.5 W/SF Office: 2.0 W/SF Kitchen: 3.6 W/SF
Plug load density	Classroom: 1.1 W/SF Computer room: 5.5 W/SF Dining area: 0.6 W/SF Office: 1.6 W/SF Kitchen: 3.3 W/SF
Operating hours	Mon-Fri: 8am – 10pm Sat: 8am – 7pm Sun: closed
HVAC system type	Combination PSZ and built-up with centrifugal chiller and hot water boiler.
HVAC system size	400 SF/ton
Thermostat set points	Occupied hours: 76 ºF cooling, 72 ºF heating Unoccupied hours: 81 ºF cooling, 67 ºF heating
Chiller type	Water cooled and air cooled
Chilled water system type	Variable volume with 2 way control valves
Chilled water system control	Constant CHW Temp, 45 ºF set point
Boiler type	Hot water, 80% efficiency
Hot water system type	Variable volume with 2 way control valves
Hot water system control	Constant HW Temp, 180 ºF set point

Each set of measures was run using each of three different HVAC system configurations: a constant volume reheat system without economizer, a constant volume reheat system with economizer, and a VAV system with economizer. The constant volume reheat system without economizer represents a system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. Thispresents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the University Building prototype is shown below.



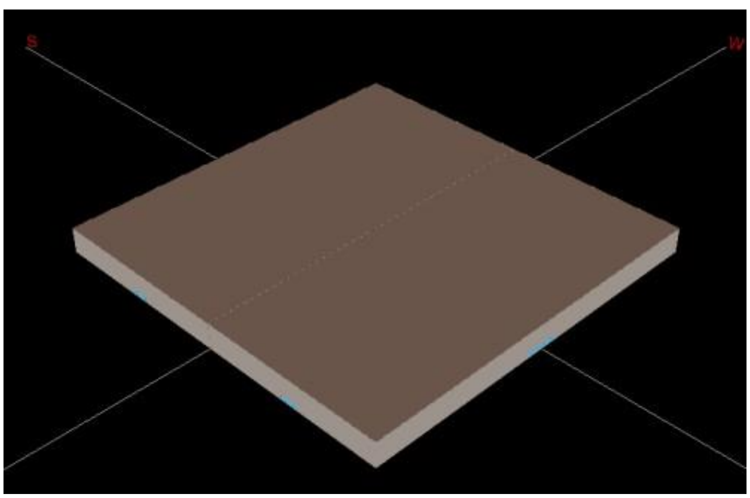
5.21 WAREHOUSE

A prototypical building energy simulation model for a warehouse building was developed usingthe DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized below.

WAREHOUSE PROTOTYPE BUILDING DESCRIPTION

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	500,000
Number of floors	1
Wall construction and insulation R-value	Concrete block, R-5
Roof construction and insulation R-value	Wood deck with built-up roof, R-12
Glazing type	Multi-pane; Shading-coefficient = 0.84U-value = 0.72
Lighting power density	0.9 W/SF
Plug load density	0.2 W/SF
Operating hours	Mon-Fri: 7am – 6pm Sat-Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	Based on ASHRAE design day conditions, 10% over-sizing assumed.
Thermostat set points	Occupied hours: 80 ^{o}F cooling, 68 ^{o}F heating Unoccupied hours: 85 ^{o}F cooling, 63 ^{o}F heating

A computer-generated sketch of the Warehouse Building prototype is shown below.



6 APPENDIX C: HEATING AND COOLING EFLH

6.1.1 RESIDENTIAL EFLH

This appendix provides heating and cooling full load hours by home type and vintage.

Table 6-1 Residential Heating and Cooling Full Load Hours

Home Type	Old (built prior to 1979)		Average (built 1979-2006)		New (built 2007-present)	
	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH	Cooling EFLH	Heating EFLH
Single-family detached (Weight = 0.61)	600	965	600	965	600	965
Multi-family low-rise (Weight = 0.37)	600	965	600	965	600	965
Multi-family high-rise (Weight 0.03)	600	965	600	965	600	965
Weighted Average	600	965	600	965	600	965

6.1.2 C&I BUILDING TYPES

This appendix provides heating and cooling full load hours by building type. A description of each building type is shown in the table below. The primary distinction between small and large buildings is the number of floors and HVAC system type rather than a specific conditioned floor area criterion. Small buildings in this study utilize packaged or split unitary system HVAC systems or packaged terminal air conditioners (PTAC). Large buildings use built-up HVAC systems with chillers and boilers.

Table 6-2 C&I Building Type Descriptions

Building Type	Description
Assembly	Public buildings that include community centers, libraries, performance and movie theaters, auditoria, police and fire stations, gymnasia, sports arenas, and transportation terminals
Auto	Repair shops and auto dealerships, including parking lots and parking structures.
Big Box	Single story, high-bay retail stores with ceiling heights of 25 feet or more. Majority of floor space is dedicated to non-food items, but could include refrigerated and non-refrigerated food sales areas.
Community College	Community college campus and post-secondary technical and vocational education buildings, including classroom, computer labs, dining and office. Conditioned by packaged HVAC systems
Dormitory	College or University dormitories
Fast Food	Self-service restaurants with primarily disposable plates, utensils etc.
Full Service Restaurant	Full service restaurants with full dishwashing facilities

Building Type	Description
Grocery	Refrigerated and non-refrigerated food sales, including convenience stores and specialty food sales
Heavy Industrial	Single or multistory buildings containing industrial processes including pump stations, water and wastewater treatment plants; may be conditioned or unconditioned.
Hospital	Inpatient and outpatient care facility conditioned by built-up HVAC systems. Excludes medical offices
Hotel	Multifunction lodging facility with guest rooms, meeting space, foodservice conditioned by built-up HVAC system
Large Office	Office space in buildings greater than 3 stories conditioned by built-up HVAC system.
Light Industrial	Single story work space with heating and air-conditioning; conditioned by packaged HVAC systems.
Multifamily high-rise	Multifamily building with more than 3 stories conditioned by built up HVAC system
Multifamily low-rise	Multifamily building with 3 stories or less conditioned by packaged HVAC system
Motel	Lodging facilities with primarily guest room space served by packaged HVAC systems
Multi Story Retail	Retail building with 2 or more stories served by built-up HVAC system
Primary School	K-8 school
Religious	Religious worship
Secondary School	9-12 school
Single-family residential	Single-family detached residences
Small Office	Office occupancy in buildings 3 stories or less served by packaged HVAC systems; includes Medical offices
Small Retail	Single story retail with ceiling height of less than 25 feet; primarily non-food retail and storage areas served by packaged HVAC systems. Includes service businesses, post offices, Laundromats, and exercise facilities.
University	University campus buildings, including classroom, computer labs, biological and/or chemical labs, workshop space, dining and office. Conditioned by built-up HVAC systems
Warehouse	Primarily non-refrigerated storage space could include attached offices served by packaged HVAC system.

Other building types not included above can be matched to the standard building types as shown below:

Table 6-3 Building Type Correlation Examples

Building Type	Best Match
Agricultural	Light industrial
Funeral home	Small retail
Police and fire stations	Public assembly

Building Type	Best Match
Courthouse	Large office
Detention facility	Multifamily highrise
Municipal airport	Assembly
Nursing home	Hospital
Kennel	Small retail
Rental office in Multifamily Building	Small office
Multifamily Interior hallways	Multifamily (hallways included in model)

Note: for commercial buildings that cannot be reasonably associated with one the building types above, savings values for the "other" category should be used.

6.1.3 C&I EFLH VALUES

The tables below show EFLH values by facility type for the five climate zone described in Appendix A: Climate Zone Descriptions.

Please note:

- Multifamily (low and high-rise) EFLH values are presented in section 6.1.1.
- All utilities should use weighted average value for EFLH.

Table 6-4 Small Commercial (less than 3 stories) Cooling Equivalent Full Load Hours ($EFLH_c$)

Facility Type	HVAC Type	Northern	Central	Pine Barrens	South-west	Coastal	Wt Average
Assembly	Packaged or split unitary system	608	742	690	680	654	693
Auto repair	Packaged or split unitary system	375	486	468	479	408	452
Light industrial	Packaged or split unitary system	481	548	496	574	485	523
Lodging – Motel	Packaged Terminal AC	947	1,023	1,065	1,063	1,039	1,022
Office – small	Packaged or split unitary system	842	931	883	941	880	904
Other	Packaged or split unitary system	707	793	766	786	741	766
Religious worship	Packaged or split unitary system	304	326	353	322	309	322
Restaurant – fast food	Packaged or split unitary system	553	695	631	670	608	647

Facility Type	HVAC Type	Northern	Central	Pine Barrens	South-west	Coastal	Wt Average
Restaurant – full service	Packaged or split unitary system	533	660	602	625	573	614
Retail – big box	Packaged or split unitary system	923	1,031	996	1,006	967	996
Retail – Grocery	Packaged or split unitary system	2,100	2,058	1,994	2,036	1,994	2,045
Retail – small	Packaged or split unitary system	846	929	899	931	873	903
School – primary	Packaged or split unitary system	332	398	410	443	369	388
Warehouse	Packaged or split unitary system	324	393	357	392	327	367

Table 6-5 Small Commercial (less than 3 stories) Heating Equivalent Full Load Hours ($EFLH_h$)

Facility Type	HVAC Type	Northern	Central	Pine Barrens	South-west	Coastal	Wt Average
Assembly	Packaged or split unitary system	775	666	653	703	796	708
Auto repair	Packaged or split unitary system	2,387	2,056	2,081	2,090	2,140	2,132
Light industrial	Packaged or split unitary system	1,044	776	768	865	927	854
Lodging – Motel	Packaged Terminal AC	521	404	415	407	478	437
Office – small	Packaged or split unitary system	586	407	427	405	472	449
Other	Packaged or split unitary system	914	749	741	785	852	796
Religious worship	Packaged or split unitary system	837	727	710	739	775	753
Restaurant – fast food	Packaged or split unitary system	1,098	894	863	958	1,056	958
Restaurant – full service	Packaged or split unitary system	1,095	904	885	953	1,061	964
Retail – big box	Packaged or split unitary system	430	345	332	358	398	368
Retail – Grocery	Packaged or split unitary system	1,022	913	861	997	1,140	971

Facility Type	HVAC Type	Northern	Central	Pine Barrens	South-west	Coastal	Wt Average
Retail – small	Packaged or split unitary system	765	581	580	604	655	626
School – primary	Packaged or split unitary system	1,060	873	850	945	1,019	933
Warehouse	Packaged or split unitary system	602	486	483	501	505	510

Table 6-6 Large Commercial (more than 3 stories) Cooling Equivalent Full Load Hours (EFLHc)

Building Type	HVAC System	Northern	Central	Pine Barrens	Southwest	Coastal	Wt Average
Dormitory	Fan coil	736	880	874	842	886	852
School – Community college	CV econ	708	826	877	859	804	812
	CV noecon	988	1,108	1,132	1,124	1,088	1,089
	VAV	560	569	674	699	586	596
	Unknown	649	692	776	790	697	706
School – secondary	CV econ	424	499	502	487	475	482
	CV noecon	824	899	870	873	879	877
	VAV	300	369	396	369	353	358
	Unknown	400	471	486	465	453	457
Hospital	CV econ	1,229	1,433	1,380	1,405	1,374	1,380
	CV noecon	2,167	2,306	2,230	2,209	2,222	2,250
	VAV	1,035	1,214	1,170	1,195	1,167	1,169
	Unknown	1,141	1,319	1,271	1,293	1,268	1,273
Hotel	CV econ	2,836	2,881	2,909	2,930	2,908	2,886
	CV noecon	3,028	3,065	3,092	3,113	3,100	3,072
	VAV	2,871	2,897	2,883	2,915	2,894	2,892
	Unknown	2,932	2,973	3,000	3,021	3,004	2,979
Large Office	CV econ	648	727	725	725	698	708
	CV noecon	2,223	2,265	2,230	2,235	2,246	2,248
	VAV	634	725	689	708	675	696
	Unknown	746	833	799	816	786	805
Large Retail	CV econ	1,006	1,167	1,157	1,130	1,107	1,125
	CV noecon	1,754	1,876	1,836	1,807	1,846	1,839

Building Type	HVAC System	Northern	Central	Pine Barrens	Southwest	Coastal	Wt Average
	VAV	832	993	972	946	940	950
	Unknown	920	1,077	1,056	1,029	1,026	1,035
School – postsecondary	CV econ	855	872	844	921	934	881
	CV noecon	1,118	1,159	1,153	1,136	1,225	1,160
	VAV	567	667	649	620	607	634
	Unknown	697	775	757	747	753	753
Other	CV econ	1,101	1,201	1,199	1,208	1,186	1,182
	CV noecon	1,729	1,811	1,792	1,785	1,801	1,791
	VAV	971	1,062	1,062	1,065	1,032	1,042
	Unknown	1,069	1,163	1,164	1,166	1,141	1,144

Table 6-7 Large Commercial (more than 3 stories) Cooling Equivalent Full Load Hours (EFLHc)

Building Type	HVAC System	Northern	Central	Pine Barrens	Southwest	Coastal	Wt Average
Dormitory	Fan coil	577	452	471	463	504	485
School – Community college	CV econ	1,501	1,371	1,383	1,485	1,358	1,404
	CV noecon	1,340	1,214	1,244	1,343	1,218	1,253
	VAV	481	390	335	509	378	410
	Unknown	772	670	638	789	660	694
School – secondary	CV econ	968	949	918	887	1,000	950
	CV noecon	907	868	844	832	914	875
	VAV	363	254	271	309	327	292
	Unknown	541	457	460	480	522	484
Hospital	CV econ	4,530	3,702	4,009	3,951	4,180	3,980
	CV noecon	4,725	4,103	4,305	3,711	3,904	4,157
	VAV	531	374	373	412	449	416
	Unknown	1,186	938	979	959	1,024	1,001
Hotel	CV econ	1,087	963	974	1,052	1,362	1,059
	CV noecon	832	713	730	772	992	786
	VAV	342	272	294	263	342	297
	Unknown	959	838	852	912	1,177	923
Large Office	CV econ	2,270	2,087	2,128	1,989	2,233	2,136
	CV noecon	2,301	2,101	2,141	1,999	2,278	2,157

Building Type	HVAC System	Northern	Central	Pine Barrens	Southwest	Coastal	Wt Average
	VAV	416	366	376	277	418	375
	Unknown	677	608	623	517	675	623
Large Retail	CV econ	2,083	2,031	2,030	2,047	2,134	2,058
	CV noecon	1,997	1,955	1,971	1,991	2,090	1,989
	VAV	726	645	632	648	787	681
	Unknown	936	861	851	867	999	895
School – postsecondary	CV econ	1,368	1,247	1,170	1,174	1,210	1,245
	CV noecon	1,314	1,108	1,070	1,081	1,086	1,132
	VAV	523	705	356	782	390	592
	Unknown	776	851	593	889	625	777
Other	CV econ	1,972	1,764	1,802	1,798	1,925	1,833
	CV noecon	1,917	1,723	1,758	1,676	1,783	1,764
	VAV	483	429	377	457	442	438
	Unknown	835	746	714	773	812	771

7 APPENDIX D: HVAC FAN AND PUMP OPERATING HOURS

This section presents HVAC fan and pump operating hours by C&I building type. These values are the result of building prototype models in Appendix B: Building Prototype Descriptions. The operating hours are differentiated by facility type, HVAC system (large commercial only), and climate region. If climate region is unavailable, default to statewide average values.

Table 7-1 Small Commercial HVAC Fan and Pump Hours

Facility Type	Climate	HVAC Fan Motor	Heating Pumps
Assembly	Central	6,884	3,741
Assembly	Coastal	6,812	3,847
Assembly	Northern	6,877	4,039
Assembly	Pine Barrens	6,784	3,674
Assembly	Southwest	6,861	3,687
Assembly	**Statewide Average**	**6,858**	**3,795**
Auto repair	Central	6,341	4,377
Auto repair	Coastal	6,312	4,463
Auto repair	Northern	6,408	4,683
Auto repair	Pine Barrens	6,311	4,296
Auto repair	Southwest	6,287	4,302
Auto repair	**Statewide Average**	**6,339**	**4,426**
Big box	Central	5,669	2,725
Big box	Coastal	5,429	2,729
Big box	Northern	5,485	2,963
Big box	Pine Barrens	5,641	2,696
Big box	Southwest	5,634	2,697
Big box	**Statewide Average**	**5,592**	**2,760**
Fast food restaurant	Central	6,940	3,958
Fast food restaurant	Coastal	6,854	4,025
Fast food restaurant	Northern	6,893	4,210
Fast food restaurant	Pine Barrens	6,818	3,845
Fast food restaurant	Southwest	6,868	3,895
Fast food restaurant	**Statewide Average**	**6,897**	**3,992**
Full service restaurant	Central	6,002	3,614

Facility Type	Climate	HVAC Fan Motor	Heating Pumps
Full service restaurant	Coastal	5,964	3,693
Full service restaurant	Northern	6,083	3,931
Full service restaurant	Pine Barrens	5,967	3,551
Full service restaurant	Southwest	5,997	3,588
Full service restaurant	**Statewide Average**	**6,005**	**3,671**
Grocery	Central	8,760	8,760
Grocery	Coastal	8,760	8,760
Grocery	Northern	8,760	8,760
Grocery	Pine Barrens	8,760	8,760
Grocery	Southwest	8,760	8,760
Grocery	**Statewide Average**	**8,760**	**8,760**
Light industrial	Central	4,752	2,596
Light industrial	Coastal	4,778	2,781
Light industrial	Northern	4,983	3,044
Light industrial	Pine Barrens	4,733	2,571
Light industrial	Southwest	4,825	2,706
Light industrial	**Statewide Average**	**4,801**	**2,711**
Motel	Central	4,540	2,216
Motel	Coastal	4,540	2,239
Motel	Northern	4,540	2,325
Motel	Pine Barrens	4,540	2,181
Motel	Southwest	4,540	2,188
Motel	**Statewide Average**	**4,540**	**2,231**
Primary school	Central	5,991	4,104
Primary school	Coastal	6,012	4,229
Primary school	Northern	6,080	4,432
Primary school	Pine Barrens	5,917	4,045
Primary school	Southwest	6,011	4,081
Primary school	**Statewide Average**	**6,004**	**4,171**
Religious	Central	3,493	1,915
Religious	Coastal	3,493	1,934
Religious	Northern	3,493	1,957

Facility Type	Climate	HVAC Fan Motor	Heating Pumps
Religious	Pine Barrens	3,493	1,835
Religious	Southwest	3,493	1,877
Religious	**Statewide Average**	**3,493**	**1,912**
Small office	Central	5,423	2,456
Small office	Coastal	5,465	2,567
Small office	Northern	5,615	2,916
Small office	Pine Barrens	5,360	2,391
Small office	Southwest	5,473	2,482
Small office	**Statewide Average**	**5,461**	**2,548**
Small retail	Central	5,767	3,169
Small retail	Coastal	5,767	3,304
Small retail	Northern	5,931	3,544
Small retail	Pine Barrens	5,711	3,118
Small retail	Southwest	5,770	3,196
Small retail	**Statewide Average**	**5,789**	**3,252**
Warehouse	Central	3,604	1,521
Warehouse	Coastal	3,604	1,610
Warehouse	Northern	3,604	1,672
Warehouse	Pine Barrens	3,604	1,489
Warehouse	Southwest	3,604	1,548
Warehouse	**Statewide Average**	**3,604**	**1,560**

Table 7-2 Large Commercial HVAC Fan and Pump Hours

Facility Type	Climate	HVAC System	HVAC Fan Motor	Chilled Water Pump	Hot Water Pump	Condenser Water Pump	Cooling Tower Fan
Community College	Central	CV econ	3,480	2,216	2,780	2,644	878
Community College	Coastal	CV econ	3,480	2,204	2,725	2,640	854
Community College	Northern	CV econ	3,480	2,161	2,826	2,582	697
Community College	Pine Barrens	CV econ	3,480	2,245	2,784	2,679	923
Community College	Southwest	CV econ	3,480	2,166	2,810	2,666	939
Community College	**Statewide Average**	**CV econ**	**3,480**	**2,202**	**2,783**	**2,639**	**855**
Community College	Central	CV noecon	3,480	2,331	2,738	2,825	964
Community College	Coastal	CV noecon	3,480	2,314	2,684	2,836	942
Community College	Northern	CV noecon	3,480	2,272	2,755	2,767	785
Community College	Pine Barrens	CV noecon	3,480	2,347	2,747	2,844	1,008
Community College	Southwest	CV noecon	3,480	2,271	2,769	2,844	1,027
Community College	**Statewide Average**	**CV noecon**	**3,480**	**2,313**	**2,737**	**2,821**	**942**
Community College	Central	VAV	2,049	3,364	3,357	2,450	611
Community College	Coastal	VAV	2,121	3,364	3,357	2,415	579
Community College	Northern	VAV	2,173	3,364	3,357	2,360	437
Community College	Pine Barrens	VAV	2,105	3,364	3,357	2,461	639
Community College	Southwest	VAV	2,075	3,364	3,357	2,475	671
Community College	**Statewide Average**	**VAV**	**2,091**	**3,364**	**3,357**	**2,433**	**586**
Community College	Central	Unknown	2,493	3,026	3,172	2,538	707
Community College	Coastal	Unknown	2,543	3,021	3,155	2,515	678
Community College	Northern	Unknown	2,578	3,008	3,181	2,457	532
Community College	Pine Barrens	Unknown	2,531	3,033	3,173	2,554	740
Community College	Southwest	Unknown	2,511	3,009	3,181	2,562	768
Community College	**Statewide Average**	**Unknown**	**2,522**	**3,021**	**3,172**	**2,525**	**683**
Dorm	Central	FPFC	3,833	3,824	3,772	2,765	489
Dorm	Coastal	FPFC	3,833	3,824	3,772	2,762	499
Dorm	Northern	FPFC	3,833	3,824	3,772	2,729	359
Dorm	Pine Barrens	FPFC	3,833	3,824	3,772	2,763	486
Dorm	Southwest	FPFC	3,834	3,824	3,772	2,772	485
Dorm	**Statewide Average**	**FPFC**	**3,833**	**3,824**	**3,772**	**2,759**	**468**

Facility Type	Climate	HVAC System	HVAC Fan Motor	Chilled Water Pump	Hot Water Pump	Condenser Water Pump	Cooling Tower Fan
Dorm	Central	Unknown	3,833	3,824	3,772	2,765	489
Dorm	Coastal	Unknown	3,833	3,824	3,772	2,762	499
Dorm	Northern	Unknown	3,833	3,824	3,772	2,729	359
Dorm	Pine Barrens	Unknown	3,833	3,824	3,772	2,763	486
Dorm	Southwest	Unknown	3,834	3,824	3,772	2,772	485
Dorm	**Statewide Average**	**Unknown**	**3,833**	**3,824**	**3,772**	**2,759**	**468**
Hospital	Central	CV econ	5,635	6,641	6,372	5,944	1,067
Hospital	Coastal	CV econ	5,588	6,615	6,752	5,904	969
Hospital	Northern	CV econ	5,635	6,632	6,477	5,864	798
Hospital	Pine Barrens	CV econ	5,651	6,624	6,449	5,940	1,023
Hospital	Southwest	CV econ	5,603	6,613	6,680	5,943	1,056
Hospital	**Statewide Average**	**CV econ**	**5,626**	**6,630**	**6,493**	**5,923**	**999**
Hospital	Central	CV noecon	5,639	6,970	6,808	6,068	1,149
Hospital	Coastal	CV noecon	5,584	6,930	6,789	5,996	1,048
Hospital	Northern	CV noecon	5,627	7,000	6,631	5,993	881
Hospital	Pine Barrens	CV noecon	5,657	6,954	6,897	6,067	1,102
Hospital	Southwest	CV noecon	5,600	6,916	6,581	6,055	1,135
Hospital	**Statewide Average**	**CV noecon**	**5,626**	**6,961**	**6,759**	**6,042**	**1,081**
Hospital	Central	VAV	5,712	6,656	5,312	5,909	991
Hospital	Coastal	VAV	5,690	6,631	6,137	5,882	906
Hospital	Northern	VAV	5,732	6,619	5,909	5,844	745
Hospital	Pine Barrens	VAV	5,736	6,626	4,730	5,912	957
Hospital	Southwest	VAV	5,704	6,628	5,997	5,912	985
Hospital	**Statewide Average**	**VAV**	**5,714**	**6,639**	**5,557**	**5,894**	**931**
Hospital	Central	Unknown	5,700	6,680	5,517	5,925	1,009
Hospital	Coastal	Unknown	5,673	6,653	6,238	5,893	922
Hospital	Northern	Unknown	5,716	6,651	6,012	5,857	760
Hospital	Pine Barrens	Unknown	5,723	6,652	5,040	5,927	974
Hospital	Southwest	Unknown	5,687	6,650	6,098	5,926	1,003
Hospital	**Statewide Average**	**Unknown**	**5,699**	**6,664**	**5,728**	**5,908**	**949**

Facility Type	Climate	HVAC System	HVAC Fan Motor	Chilled Water Pump	Hot Water Pump	Condenser Water Pump	Cooling Tower Fan
Hotel	Central	CV econ	8,664	6,026	7,310	6,992	2,490
Hotel	Coastal	CV econ	8,665	5,744	7,309	6,939	2,347
Hotel	Northern	CV econ	8,668	5,918	7,328	6,839	2,025
Hotel	Pine Barrens	CV econ	8,665	5,772	7,313	6,988	2,438
Hotel	Southwest	CV econ	8,664	6,042	7,306	7,016	2,516
Hotel	**Statewide Average**	**CV econ**	**8,665**	**5,936**	**7,313**	**6,960**	**2,385**
Hotel	Central	CV noecon	8,664	6,527	7,234	7,967	3,335
Hotel	Coastal	CV noecon	8,665	6,243	7,227	7,940	3,233
Hotel	Northern	CV noecon	8,668	6,424	7,248	7,826	2,850
Hotel	Pine Barrens	CV noecon	8,665	6,249	7,238	7,958	3,284
Hotel	Southwest	CV noecon	8,664	6,539	7,228	7,967	3,336
Hotel	**Statewide Average**	**CV noecon**	**8,665**	**6,435**	**7,235**	**7,938**	**3,231**
Hotel	Central	VAV	8,619	5,372	6,172	6,857	2,210
Hotel	Coastal	VAV	8,617	5,142	7,179	6,801	2,062
Hotel	Northern	VAV	8,618	5,456	6,178	6,689	1,733
Hotel	Pine Barrens	VAV	8,619	5,593	6,178	6,856	2,150
Hotel	Southwest	VAV	8,619	5,384	7,185	6,875	2,206
Hotel	**Statewide Average**	**VAV**	**8,619**	**5,375**	**6,446**	**6,822**	**2,098**
Hotel	Central	Unknown	8,664	6,026	7,310	6,992	2,490
Hotel	Coastal	Unknown	8,665	5,744	7,309	6,939	2,347
Hotel	Northern	Unknown	8,668	5,918	7,328	6,839	2,025
Hotel	Pine Barrens	Unknown	8,665	5,772	7,313	6,988	2,438
Hotel	Southwest	Unknown	8,664	6,042	7,306	7,016	2,516
Hotel	**Statewide Average**	**Unknown**	**8,665**	**5,936**	**7,313**	**6,960**	**2,385**
High School	Central	CV econ	1,953	1,127	1,319	1,644	612
High School	Coastal	CV econ	1,953	1,126	1,322	1,643	595
High School	Northern	CV econ	1,953	1,108	1,351	1,610	518
High School	Pine Barrens	CV econ	1,953	1,142	1,400	1,663	639
High School	Southwest	CV econ	1,953	1,141	1,317	1,654	609
High School	**Statewide Average**	**CV econ**	**1,953**	**1,127**	**1,333**	**1,641**	**596**

Facility Type	Climate	HVAC System	HVAC Fan Motor	Chilled Water Pump	Hot Water Pump	Condenser Water Pump	Cooling Tower Fan
High School	Central	CV noecon	1,953	1,372	1,311	1,881	855
High School	Coastal	CV noecon	1,953	1,398	1,313	1,882	848
High School	Northern	CV noecon	1,953	1,342	1,259	1,848	768
High School	Pine Barrens	CV noecon	1,953	1,344	1,350	1,875	860
High School	Southwest	CV noecon	1,953	1,335	1,310	1,872	835
High School	**Statewide Average**	**CV noecon**	**1,953**	**1,364**	**1,307**	**1,874**	**838**
High School	Central	VAV	1,522	1,120	969	1,583	489
High School	Coastal	VAV	1,502	1,132	1,042	1,571	462
High School	Northern	VAV	1,480	1,099	1,007	1,539	384
High School	Pine Barrens	VAV	1,520	1,146	973	1,592	512
High School	Southwest	VAV	1,507	1,141	995	1,581	477
High School	**Statewide Average**	**VAV**	**1,510**	**1,124**	**990**	**1,574**	**468**
High School	Central	Unknown	1,655	1,160	1,076	1,638	565
High School	Coastal	Unknown	1,642	1,172	1,128	1,631	542
High School	Northern	Unknown	1,627	1,138	1,099	1,598	464
High School	Pine Barrens	Unknown	1,654	1,176	1,098	1,647	585
High School	Southwest	Unknown	1,645	1,171	1,094	1,638	553
High School	**Statewide Average**	**Unknown**	**1,647**	**1,161**	**1,093**	**1,631**	**545**
Large Office	Central	CV econ	4,956	2,938	2,435	4,273	558
Large Office	Coastal	CV econ	4,966	2,972	2,495	4,328	476
Large Office	Northern	CV econ	4,963	2,922	2,529	4,290	379
Large Office	Pine Barrens	CV econ	4,950	2,967	2,465	4,329	512
Large Office	Southwest	CV econ	4,917	2,973	2,462	4,323	567
Large Office	**Statewide Average**	**CV econ**	**4,954**	**2,948**	**2,467**	**4,297**	**510**
Large Office	Central	CV noecon	4,955	3,418	2,421	5,076	678
Large Office	Coastal	CV noecon	4,960	3,473	2,479	5,183	605
Large Office	Northern	CV noecon	4,953	3,431	2,512	5,133	499
Large Office	Pine Barrens	CV noecon	4,946	3,435	2,449	5,137	633
Large Office	Southwest	CV noecon	4,904	3,450	2,446	5,134	689
Large Office	**Statewide Average**	**CV noecon**	**4,949**	**3,434**	**2,452**	**5,116**	**632**

Facility Type	Climate	HVAC System	HVAC Fan Motor	Chilled Water Pump	Hot Water Pump	Condenser Water Pump	Cooling Tower Fan
Large Office	Central	VAV	3,866	2,810	2,268	3,937	289
Large Office	Coastal	VAV	3,862	2,815	2,295	3,957	239
Large Office	Northern	VAV	3,914	2,779	2,338	3,949	182
Large Office	Pine Barrens	VAV	3,900	2,827	2,291	3,964	266
Large Office	Southwest	VAV	3,837	2,848	2,291	3,985	304
Large Office	**Statewide Average**	**VAV**	**3,874**	**2,811**	**2,289**	**3,951**	**262**
Large Office	Central	Unknown	4,018	2,861	2,290	4,040	335
Large Office	Coastal	Unknown	4,016	2,872	2,322	4,069	282
Large Office	Northern	Unknown	4,060	2,835	2,364	4,056	218
Large Office	Pine Barrens	Unknown	4,047	2,879	2,314	4,072	309
Large Office	Southwest	Unknown	3,987	2,899	2,314	4,089	350
Large Office	**Statewide Average**	**Unknown**	**4,025**	**2,865**	**2,313**	**4,056**	**305**
Large Retail	Central	CV econ	4,540	2,364	2,183	3,531	1,124
Large Retail	Coastal	CV econ	4,540	2,334	2,181	3,503	1,051
Large Retail	Northern	CV econ	4,540	2,283	2,191	3,457	905
Large Retail	Pine Barrens	CV econ	4,540	2,368	2,184	3,552	1,123
Large Retail	Southwest	CV econ	4,540	2,369	2,185	3,539	1,130
Large Retail	**Statewide Average**	**CV econ**	**4,540**	**2,347**	**2,184**	**3,517**	**1,075**
Large Retail	Central	CV noecon	4,540	2,633	2,123	3,840	1,314
Large Retail	Coastal	CV noecon	4,540	2,614	2,118	3,813	1,257
Large Retail	Northern	CV noecon	4,540	2,568	2,127	3,774	1,088
Large Retail	Pine Barrens	CV noecon	4,540	2,632	2,125	3,845	1,306
Large Retail	Southwest	CV noecon	4,540	2,637	2,124	3,838	1,315
Large Retail	**Statewide Average**	**CV noecon**	**4,540**	**2,619**	**2,123**	**3,825**	**1,266**
Large Retail	Central	VAV	4,201	2,276	1,901	3,215	746
Large Retail	Coastal	VAV	4,176	2,251	1,893	3,181	685
Large Retail	Northern	VAV	4,172	2,203	1,910	3,144	560
Large Retail	Pine Barrens	VAV	4,201	2,279	1,901	3,207	732
Large Retail	Southwest	VAV	4,183	2,280	1,898	3,229	750
Large Retail	**Statewide Average**	**VAV**	**4,190**	**2,260**	**1,901**	**3,198**	**704**

Facility Type	Climate	HVAC System	HVAC Fan Motor	Chilled Water Pump	Hot Water Pump	Condenser Water Pump	Cooling Tower Fan
Large Retail	Central	Unknown	4,255	2,311	1,941	3,291	822
Large Retail	Coastal	Unknown	4,234	2,287	1,934	3,258	760
Large Retail	Northern	Unknown	4,231	2,239	1,950	3,219	630
Large Retail	Pine Barrens	Unknown	4,256	2,315	1,941	3,286	809
Large Retail	Southwest	Unknown	4,240	2,316	1,939	3,303	826
Large Retail	**Statewide Average**	**Unknown**	**4,246**	**2,296**	**1,941**	**3,274**	**778**
University	Central	CV econ	3,943	2,792	3,318	3,307	1,319
University	Coastal	CV econ	3,943	2,867	3,280	3,292	1,276
University	Northern	CV econ	3,943	2,869	3,311	3,268	1,142
University	Pine Barrens	CV econ	3,943	2,555	3,277	3,336	1,386
University	Southwest	CV econ	3,943	2,850	3,287	3,316	1,360
University	**Statewide Average**	**CV econ**	**3,943**	**2,797**	**3,303**	**3,302**	**1,294**
University	Central	CV noecon	3,943	3,212	3,228	3,714	1,866
University	Coastal	CV noecon	3,943	3,286	3,240	3,680	1,832
University	Northern	CV noecon	3,943	3,163	3,273	3,652	1,676
University	Pine Barrens	CV noecon	3,943	3,213	3,244	3,679	1,870
University	Southwest	CV noecon	3,943	3,207	3,224	3,693	1,883
University	**Statewide Average**	**CV noecon**	**3,943**	**3,215**	**3,239**	**3,692**	**1,830**
University	Central	VAV	2,548	2,503	2,977	3,246	1,192
University	Coastal	VAV	2,608	2,368	2,452	3,253	1,175
University	Northern	VAV	2,553	2,503	2,618	3,196	1,002
University	Pine Barrens	VAV	2,642	2,531	2,349	3,275	1,268
University	Southwest	VAV	2,605	2,257	3,116	3,267	1,248
University	**Statewide Average**	**VAV**	**2,575**	**2,457**	**2,778**	**3,244**	**1,172**
University	Central	Unknown	2,980	2,658	3,069	3,328	1,316
University	Coastal	Unknown	3,021	2,588	2,702	3,325	1,293
University	Northern	Unknown	2,984	2,662	2,827	3,278	1,128
University	Pine Barrens	Unknown	3,045	2,640	2,632	3,347	1,380
University	Southwest	Unknown	3,020	2,496	3,159	3,341	1,364
University	**Statewide Average**	**Unknown**	**2,999**	**2,627**	**2,931**	**3,322**	**1,293**

8 APPENDIX E: CODE-COMPLIANT EFFICIENCIES

This appendix includes code-compliant effincies for HVAC and hot water equipment. These efficiency ratings should be used as baseline parameters according to the following guidelines, unless otherwise specified in the measure:

- When a measure calls for code baseline (TOS/NC), use the current NJ building code. At the time of this writing, NJ building code is defined by ASHRAE 90.1-2019, IECC 2021, and the 2022 Code of Federal Regulations.
- When a measure calls for exising baseline (EREP/RF/ERET), use the actual site-specific efficiency if possible. If the site-specific efficiency unknown, use the code-compliant efficiency from the year of installation. Code-compliant efficiencies from 2013 (10 year vintage) are included here and may be used if the installation year cannot be estimated.

8.1 CONVERTING BETWEEN SEER/SEER2, HSPF/HSPF2

To covert between SEER and SEER2 or HSPF and HSPF2, use the table below (interpolate as needed)

Table 8-1 SEER/SEER2 and HSPF/HSPF2 Conversions

SEER2	SEER	HSPF2	HSPF
13.4	14	6.7	8.0
14.3	15	7.1	8.5
15.2	16	7.5	8.8
16	17	7.8	9.2
17	18	8	9.5
18	19	8.4	10
19	20	8.5	10.2
20	21	8.9	10.8
21	22	9.1	11
22	23	9.3	11.3
23	24	9.7	11.9
		10	12.4
		10.4	12.9

EER2 may be calculated from the ratio of SEER to SEER2:

$$EER2 = EER \times \frac{SEER2}{SEER}$$

For example, EER2 values for SEER rated split system air conditioners and split system heat pumps are shown below.

Table 8-2 EER/EER2 Conversions

Equipment Type	SEER	SEER2	EER	EER2	EER2/EER
Split system Air conditioner	14	13.4	11.3	10.8	0.96
Split system heat pump	15	14.3	12.1	11.5	0.95

8.2 HVAC EFFICIENCIES

Table 8-2 Minimum A/C and Heat Pump Efficiencies

Equipment Type and Capacity	Heating Type	Cooling Efficiencies		Heating Efficiencies	
		2013 Minimum Efficiency	2019 Minimum Efficiency	2013 Minimum Efficiency	2019 Minimum Efficiency
Air Source Air Conditioners					
< 65,000 Btu/h	All	13 SEER	13.4 SEER2	N/A	N/A
≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance	11.2 EER, 12.9 IEER	11.2 EER, 14.8 IEER	N/A	N/A
	Other	11.0 EER, 12.7 IEER	11 EER, 14.6 IEER		
≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance	11.0 EER, 12.4 IEER	11 EER, 14.2 IEER	N/A	N/A
	Other	10.8 EER, 12.2 IEER	10.8 EER, 14 IEER		
≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance	10.0 EER, 11.6 IEER	10 EER, 13.2 IEER	N/A	N/A
	Other	9.8 EER, 11.4 IEER	9.8 EER, 13 IEER		
≥ 760,000 Btu/h	Electric Resistance	9.7 EER, 11.2 IEER	9.7 EER, 12.5 IEER	N/A	N/A
	Other	9.5 EER, 11.0 IEER	9.5 EER, 12.3 IEER		
Air Source Heat Pumps					
< 65,000 Btu/h	All	14 SEER	14.3 SEER2 (Split), 13.4 SEER2 (Package)	8.2 HSPF (Split), 8.0 HSPF (Package)	7.5 HSPF2 (Split), 6.7 HSPF2 (Package)

Equipment Type and Capacity	Heating Type	Cooling Efficiencies		Heating Efficiencies	
		2013 Minimum Efficiency	2019 Minimum Efficiency	2013 Minimum Efficiency	2019 Minimum Efficiency
≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance	11 EER, 12.2 IEER	11.0 EER, 14.1 IEER	3.3 COP_H (47F db/43F wb OA) 2.25 COP_H (17F db/15F wb OA)	3.4 COP_H (47F db/43F wb OA) 2.25 COP_H (17F db/15F wb OA)
	Other	10.8 EER, 12.0 IEER	10.8 EER, 13.9 IEER		
≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance	10.6 EER, 11.6 IEER	10.6 EER, 13.5 IEER	3.2 COP_H (47F db/43F wb OA) 2.05 COP_H (17F db/15F wb OA)	3.2 COP_H (47F db/43F wb OA) 2.05 COP_H (17F db/15F wb OA)
	Other	10.4 EER, 11.4 IEER	10.4 EER, 13.3 IEER		
≥ 240,000 Btu/h	Electric Resistance	9.5 EER, 10.6 IEER	9.5 EER, 12.5 IEER	3.2 COP_H (47F db/43F wb OA) 2.05 COP_H (17F db/15F wb OA)	3.2 COP_H (47F db/43F wb OA) 2.05 COP_H (17F db/15F wb OA)
	Other	9.3 EER, 10.4 IEER	9.3 EER, 12.3 IEER		
Water-cooled air conditioner					
< 65,000 Btu/h	All	12.1 EER, 12.3 IEER	12.1 EER, 12.3 IEER	N/A	N/A
≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance	12.1 EER, 13.9 IEER	12.1 EER, 13.9 IEER	N/A	N/A
	Other	11.9 EER, 13.7 IEER	11.9 EER, 13.7 IEER		
≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance	12.5 EER, 13.9 IEER	12.5 EER, 13.9 IEER	N/A	N/A
	Other	12.3 EER, 13.7 IEER	12.3 EER, 13.7 IEER		
≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance	12.4 EER, 13.6 IEER	12.4 EER, 13.6 IEER	N/A	N/A
	Other	12.2 EER, 13.4 IEER	12.2 EER, 13.4 IEER		
≥ 760,000 Btu/h	Electric Resistance	12.2 EER, 13.5 IEER	12.2 EER, 13.5 IEER	N/A	N/A
	Other	12.0 EER, 13.3 IEER	12.0 EER, 13.3 IEER		
Evaporatively-cooled Air Conditioner					
< 65,000 Btu/h	All	12.1 EER, 12.3 IEER	12.1 EER, 12.3 IEER	N/A	N/A
≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance	12.1 EER, 12.3 IEER	12.1 EER, 12.3 IEER	N/A	N/A
	Other	11.9 EER, 12.1 IEER	11.9 EER, 12.1 IEER		
≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance	12.0 EER, 12.2 IEER	12.0 EER, 12.2 IEER	N/A	N/A
	Other	11.8 EER, 12.0 IEER	11.8 EER, 12.0 IEER		
≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance	11.9 EER, 12.1 IEER	11.9 EER, 12.1 IEER	N/A	N/A
	Other	11.7 EER, 11.9 IEER	11.7 EER, 11.9 IEER		

Equipment Type and Capacity	Heating Type	Cooling Efficiencies		Heating Efficiencies	
		2013 Minimum Efficiency	2019 Minimum Efficiency	2013 Minimum Efficiency	2019 Minimum Efficiency
≥ 760,000 Btu/h	Electric Resistance	11.7 EER, 11.9 IEER	11.7 EER, 11.9 IEER	N/A	N/A
	Other	11.5 EER, 11.7 IEER	11.5 EER, 11.7 IEER		

Table 8-3 Minimum Boiler Efficiencies

Boiler Type	Size Category (kBtu input)	2013 Minimum Efficiency	2019 Minimum Efficiency
Hot Water- Gas Fired	<300	82% AFUE	82% AFUE
	≥300 and ≤ 2,500	80% Et	80% Et
	>2,500	82% Ec	82% Ec
Hot Water- Oil Fired	<300	84% AFUE	84% AFUE
	≥300 and ≤ 2,500	82% Et	82% Et
	>2,500	84% Ec	84% Ec
Steam- Gas Fired	<300	80% AFUE	80% AFUE
Steam- Gas Fired All except Natural Draft	≥300 and ≤ 2,500	79% Et	79% Et
	>2,500	79% Et	79% Et
Steam- Gas Fired Natural Draft	≥300 and ≤ 2,500	79% Et	79% Et
	>2,500	79% Et	79% Et
Steam-Oil Fired	<300	82% AFUE	82% AFUE
	≥300 and ≤ 2,500	81% Et	81% Et
	>2,500	81% Et	81% Et

Table 8-4 Minimum Furnace and Unit Heater Efficiencies

Equipment Type	Size Category (kBtu input)	2013 Minimum Efficiency	2019 Minimum Efficiency
Gas Fired Furnace	< 225	78% AFUE or 80% E_t	Nonweatherized 80% AFUE Weatherized 81% AFUE
Gas Fired Furnace	≥ 225	80% Ec	81% Et
Oil Fired Furnace	< 225	78% AFUE or 80% E_t	Nonweatherized excluding mobile home: 83% AFUE Nonweatherized mobile home: 75% AFUE Weatherized: 78% AFUE

Equipment Type	Size Category (kBtu input)	2013 Minimum Efficiency	2019 Minimum Efficiency
Oil Fired Furnace	≥ 225	81% Et	82% Et
Gas Fired Unit Heaters	All Capacities	80% Ec	80% Ec
Oil Fired Unit Heaters	All Capacities	80% Ec	80% Ec

Table 8-5 Room A/C Minimum Efficiency – 2019

Equipment Type	Size Category (Btu/h input)	2019 Minimum Efficiency
Room air conditioners without reverse cycle with louvered sides	<6,000 Btu/h	11.0 CEER
	≥6,000 Btu/h and <8,000 Btu/h	11.0 CEER
	≥8,000 Btu/h and <14,000 Btu/h	10.9 CEER
	≥14,000 Btu/h and <20,000 Btu/h	10.7 CEER
	≥20,000 Btu/h and <28,000 Btu/h	9.4 CEER
	≥28,000 Btu/h	9.0 CEER
Room air conditioners without reverse cycle without louvered sides	<6,000 Btu/h	10.0 CEER
	≥6,000 Btu/h and <8,000 Btu/h	10.0 CEER
	≥8,000 Btu/h and <11,000 Btu/h	10.0 CEER
	≥11,000 Btu/h and <14,000 Btu/h	9.6 CEER
	≥14,000 Btu/h and <20,000 Btu/h	9.5 CEER
	≥20,000 Btu/h	9.3 CEER
	<6,000 Btu/h	9.4 CEER
Room air conditioners with reverse cycle, with louvered sides	<20,000 Btu/h	9.8 CEER
	≥20,000 Btu/h	9.3 CEER
Room air conditioners with reverse cycle without louvered sides	<14,000 Btu/h	9.3 CEER
	≥14,000 Btu/h	8.7 CEER
Room air conditioners, casement only	All	9.5 CEER
Room air conditioners, casement slider	All	10.4 CEER

Table 8-6 Room A/C Minimum Efficiency – 2013

Equipment Type	Size Category (kBtu input)	2013 Minimum Efficiency
Room air conditioners without louvered sides	<8,000 Btu/h	9.0 EER
	≥8,000 Btu/h and <20,000 Btu/h	8.5 EER
	≥20,000 Btu/h	8.5 EER
Room air conditioner heat pumps with louvered sides	<20,000 Btu/h	9.0 EER
	≥20,000 Btu/h	8.5 EER
Room air conditioner heat pumps without louvered sides	<14,000 Btu/h	8.5 EER
	≥14,000 Btu/h	8.0 EER
Room air conditioner, casement only	All	8.7 EER
Room air conditioner, casement slider	All	9.5 EER

8.3 WATER HEATING EFFICIENCIES

Table 8-7 Minimum UEF Rating (ASHRAE 90.1-2019)

Product Class	Rated Storage Volume and Input Rating	First Hour Rating	UEF_b
Electric Storage Water Heater	≥ 20 gal and ≤ 55 gal	< 18 gallons	$0.8808 - (0.0008 \times v_t)$
		≥ 18 and < 51 gallons	$0.9254 - (0.0003 \times v_t)$
		≥ 51 and < 75 gallons	$0.9307 - (0.0002 \times v_t)$
		≥ 75 gallons	$0.9349 - (0.0001 \times v_t)$
	> 55 gal and ≤ 120 gal	< 18 gallons	$1.9236 - (0.0011 \times v_t)$
		≥ 18 and < 51 gallons	$2.0440 - (0.0011 \times v_t)$
		≥ 51 and < 75 gallons	$2.1171 - (0.0011 \times v_t)$
		≥ 75 gallons	$2.2418 - (0.0011 \times v_t)$
Gas-Fired Storage Water Heater	≥ 20 gal and ≤ 55 gal	< 18 gallons	$0.3456 - (0.0020 \times v_t)$
		≥ 18 and < 51 gallons	$0.5982 - (0.0019 \times v_t)$
		≥ 51 and < 75 gallons	$0.6483 - (0.0017 \times v_t)$
		≥ 75 gallons	$0.6920 - (0.0013 \times v_t)$
	> 55 gal and ≤ 100 gal	< 18 gallons	$0.6470 - (0.0006 \times v_t)$
		≥ 18 and < 51 gallons	$0.7689 - (0.0005 \times v_t)$
		≥ 51 and < 75 gallons	$0.7897 - (0.0004 \times v_t)$
		≥ 75 gallons	$0.8072 - (0.0003 \times v_t)$

9 APPENDIX F: HVAC INTERACTIVITY FACTORS

The values below are taken from NY TRM v10, Appendix D, for NYC. NYC climate is the most similar to a statewide NJ approximation of the NY weather cities. These values are to be used if there is not a measure-specific value presented. If the building and/or HVAC system type is unknown, the default values in Table 9-1 may be used.

Table 9-1 Default Values

HVACc	HVACd	HVACff
0.080	0.175	-0.002

Table 9-2 Residential and Small Commercial

Building Type	AC with fuel heat			Heat Pump			AC with electric heat			Electric heat only			Fuel Heat only		
	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff
Single-Family Residential	0.077	0.085	-0.002	-0.105	0.111	0.000	-0.579	0.085	0.000	-0.403	0.000	0.000	0.000	0.000	-0.002
Multifamily low rise	0.055	0.136	-0.002	-0.064	0.163	0.000	-0.260	0.136	0.000	-0.320	0.000	0.000	-0.005	0.000	-0.002
Assembly	0.160	0.200	-0.002	-0.052	0.200	0.000	-0.243	0.200	0.000	-0.400	0.000	0.000	0.000	0.000	-0.002
Auto Repair	0.076	0.200	-0.004	-0.308	0.200	0.000	-0.795	0.200	0.000	-0.891	0.000	0.000	0.000	0.000	-0.004
Big Box	0.170	0.200	-0.001	0.055	0.200	0.000	-0.065	0.200	0.000	-0.226	0.000	0.000	0.000	0.000	-0.001
Elementary School	0.110	0.200	-0.003	-0.150	0.200	0.000	-0.481	0.200	0.000	-0.646	0.000	0.000	0.000	0.000	-0.003
Fast Food	0.110	0.200	-0.003	-0.471	0.200	0.000	-0.471	0.200	0.000	-0.827	0.000	0.000	0.000	0.000	-0.004
Full Service Restaurant	0.110	0.200	-0.003	-0.486	0.200	0.000	-0.486	0.200	0.000	-0.637	0.000	0.000	0.000	0.000	-0.003
Grocery	0.170	0.200	-0.001	0.055	0.200	0.000	-0.065	0.200	0.000	-0.226	0.000	0.000	0.000	0.000	-0.001
Light Industrial	0.100	0.200	-0.002	-0.083	0.200	0.000	-0.313	0.200	0.000	-0.415	0.000	0.000	0.000	0.000	-0.002
Motel	0.114	0.200	-0.002	-0.155	0.200	0.000	-0.340	0.200	0.000	-0.482	0.000	0.000	0.000	0.000	-0.002
Religious	0.092	0.200	-0.001	-0.060	0.200	0.000	-0.199	0.200	0.000	-0.291	0.000	0.000	0.000	0.000	-0.001
Small Office	0.120	0.200	-0.002	-0.003	0.200	0.000	-0.157	0.200	0.000	-0.239	0.000	0.000	0.000	0.000	-0.001
Small Retail	0.130	0.200	-0.002	-0.044	0.200	0.000	-0.258	0.200	0.000	-0.375	0.000	0.000	0.000	0.000	-0.002
Warehouse	0.078	0.200	-0.002	-0.109	0.200	0.000	-0.273	0.200	0.000	-0.352	0.000	0.000	0.000	0.000	-0.002
Other	0.114	0.200	-0.002	-0.155	0.200	0.000	-0.340	0.200	0.000	-0.482	0.000	0.000	0.000	0.000	-0.002

Table 9-3 Multifamily High Rise and College Dormitory

	Fan coil with chiller and hot water boiler			Steam heat only		
	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff
Multifamily high rise	0.101	0.194	-0.002	0.000	0.000	-0.002
College dormitory	0.025	0.200	-0.001	0.000	0.000	-0.001

Table 9-4 Large Commercial

Facility Type	CV No Econ			CV Econ			VAV Econ		
	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff	HVACc	HVACd	HVACff
Community College	0.044	0.200	-0.003	0.019	0.200	-0.002	0.124	0.200	0.000
High School	0.042	0.200	-0.003	0.022	0.200	-0.003	0.049	0.200	-0.002
Hospital	0.033	0.200	-0.002	0.019	0.200	-0.002	0.065	0.200	-0.001
Hotel	0.033	0.200	-0.002	0.019	0.200	-0.002	0.065	0.200	-0.001
Large Office	0.033	0.200	-0.002	0.019	0.200	-0.002	0.065	0.200	-0.001
Large Retail	0.037	0.200	-0.002	0.023	0.200	-0.002	0.057	0.200	-0.002
University	0.048	0.200	-0.003	0.020	0.200	-0.003	0.142	0.200	-0.001

Table 9-5 Refrigerated Warehouse

Facility Type	Water Cooled Ammonia Screw Compressors	
	HVACc	HVACd
Refrigerated Warehouse	0.390	0.200

10 APPENDIX G: NATURAL GAS PEAK DAY FACTORS

Peak gas savings are calculated on a therm/day basis, using peak day heating degree-days representing the weather conditions under which the natural gas distribution system reaches peak capacity. Design day conditions from the London Economics study are used to calculate peak gas savings:[158]

Table 10-1 Design Day Conditions

Condition	Average Heating Degree days base 65 (Deg F – day)	Average Daily Temperature (Deg F)
Winter Design Day	66.4	-1.4

Peak Day Factors (PDF) are defined as the ratio of the gas savings during the gas peak day to the annual gas savings. Peak day factors are defined using one of four methods depending on the measure type:

Table 10-2 Peak Day Factor Methods

Peak Day Factor Method	Definition	Measure Type
1 - day per year ratio	= 1/days per year	Used for non weather sensitive measure that may be in operation for different number of days per year.
2 - FLH ratio	FLH (peak gas day) / Annual FLH	Weather sensitive measures where the annual savings are expressed as a function of heating equivalent full load hours
3 - HDD ratio	HDD peak gas day / Annual HDD	Weather sensitive measures where the annual savings are expressed as a function of heating degree days
4 - hr per year ratio	24 / annual heating hr per year	HVAC interactive effects of lighting or other internal loads on heating energy

10.1 MEASURE LIST

The following Table shows the PDF method assignment and the PDF value or PDF table lookup for each measure in the TRM. Note, if the PDF method is N/A, the measure does not save gas during the peak day and the PDF is zero.

Table 10-3 Residential Measure PDF Method Assignment

End-Use	Measure Name	PDF method	PDF
Appliance Recycling	Dehumidifier recycling	N/A	
Appliance Recycling	Refrigerator & Freezer recycling	N/A	
Appliance Recycling	Room A/C recycling	N/A	

[158] Reference London Economics study

End-Use	Measure Name	PDF method	PDF
Appliances	Air purifier	N/A	
Appliances	Clothes dryer	1 - day per year ratio	0.002740
Appliances	Clothes washer	1 - day per year ratio	0.002740
Appliances	Dehumidifier	N/A	
Appliances	Dishwasher	1 - day per year ratio	0.002740
Appliances	Freezer	N/A	
Appliances	Range	1 - day per year ratio	0.002740
Appliances	Refrigerator	N/A	
Appliances	Room A/C	N/A	
Appliances	Water cooler	N/A	
HVAC	Boiler controls	N/A	
HVAC	Ceiling fan	N/A	
HVAC	Central AC, Heat Pumps, Mini-Splits, PTAC, PTHP	2 - FLH ratio	See Table 10-8
HVAC	Duct insulation & sealing	2 - FLH ratio	See Table 10-8
HVAC	EC Motors	2 - FLH ratio	See Table 10-8
HVAC	Filter whistle	N/A	
HVAC	Furnace	2 - FLH ratio	See Table 10-8
HVAC	Ground Loop and Air-to-Water Heat Pump	N/A	
HVAC	Heat or energy recovery ventilator	2 - FLH ratio	See Table 10-8
HVAC	Maintenance	2 - FLH ratio	See Table 10-8
HVAC	Smart Thermostat	2 - FLH ratio	See Table 10-8
HVAC	Ventilation fan	N/A	
Lighting	Controls	2 - FLH ratio	See Table 10-8
Lighting	Lamps and fixtures	2 - FLH ratio	See Table 10-8
Plug load	EV charger	N/A	
Plug load	Office equipment	1 - day per year ratio	0.002740
Plug load	Smart strip	N/A	
Plug load	Sound bar	N/A	
Plug load	Televisions	N/A	
Shell	Air sealing	3 - HDD ratio	See Table 10-11
Shell	Insulation	3 - HDD ratio	See Table 10-11
Water heating	Faucet aerator	1 - day per year ratio	0.002740

End-Use	Measure Name	PDF method	PDF
Water heating	Heat pump water heater	1 - day per year ratio	0.002740
Water heating	Indirect water heater	1 - day per year ratio	0.002740
Water heating	Pipe insulation	1 - day per year ratio	0.002740
Water heating	Pool pump	N/A	
Water heating	Storage water heater	1 - day per year ratio	0.002740
Water heating	Tankless water heater	1 - day per year ratio	0.002740
Water heating	Thermostatic showerhead	1 - day per year ratio	0.002740
Water heating	Water heating controls	1 - day per year ratio	0.002740
Whole building	Behavior	2 - FLH ratio	See Table 10-8
Whole building	Home Performance with Energy Star (HPwES)	2 - FLH ratio	See Table 10-8

Table 10-4 Commercial and Industrial Measures PDF Method Assignment

End-Use	Measure Name	PDF method	PDF
Agriculture	Auto Milker Takeoff	N/A	
Agriculture	Dairy pump VFD	N/A	
Agriculture	Dairy Refrigeration Tune-Up	N/A	
Agriculture	Dairy Scroll Compressor	N/A	
Agriculture	Engine Block Heater Timer	N/A	
Agriculture	Heat Reclaimers	1 - day per year ratio	0.002740
Agriculture	Livestock waterer	N/A	
Agriculture	Low pressure irrigation	N/A	
Agriculture	Ventilation fans	N/A	
Appliance Recycling	Dehumidifier Recycling	N/A	
Appliance Recycling	Freezer & Refrigerator Recycling	N/A	
Appliance Recycling	Room A/C Unit Recycling	N/A	
Appliance	Clothes dryer	1 - day per year ratio	See Table 10-6

End-Use	Measure Name	PDF method	PDF
Appliance	Clothes Dryer modulating valve	1 - day per year ratio	See Table 10-6
Appliance	Clothes washer	1 - day per year ratio	See Table 10-6
Appliance	Dehumidifier	N/A	
Appliance	Freezers	N/A	
Appliance	Refrigerators	N/A	
Appliance	Room Air Conditioner	N/A	
Appliance	Water Cooler	N/A	
Foodservice	Dishwashers	1 - day per year ratio	See Table 10-6
Foodservice	Griddles	1 - day per year ratio	See Table 10-6
Foodservice	Holding cabinets	N/A	
Foodservice	Ice Machines	N/A	
HVAC	Advanced Rooftop Controls (ARC)	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Boiler controls	N/A	
HVAC	Boiler economizer	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Central A/C, Air Source Heat Pumps, Mini-Splits, PTAC	N/A	
HVAC	Chillers	N/A	
HVAC	Demand controlled kitchen ventilation	3 - HDD ratio	See Table 10-11
HVAC	Demand controlled ventilation	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	EC Motors	4 - hr per year ratio	See Table 10-12 and Table 10-13
HVAC	Economizer controls	N/A	
HVAC	Furnace	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Gas chillers	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Geothermal and Water Source Heat Pumps	N/A	
HVAC	Guest Room EMS	2 - FLH ratio	See Table 10-9 and Table 10-10

End-Use	Measure Name	PDF method	PDF
HVAC	Heat and energy recovery ventilators	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Infrared heating	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Maintenance	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Makeup air unit	2 - FLH ratio	See Table 10-9 and Table 10-10
HVAC	Programmable & Smart Tstats	2 - FLH ratio	See Table 10-9 and Table 10-10
Lighting	Delamping	4 - hr per year ratio	See Table 10-12 and Table 10-13
Lighting	Exit signs	4 - hr per year ratio	See Table 10-12 and Table 10-13
Lighting	Indoor Ag	N/A	
Lighting	LED sign lighting	N/A	
Lighting	Lighting controls	4 - hr per year ratio	See Table 10-12 and Table 10-13
Lighting	Lighting Fixtures	4 - hr per year ratio	See Table 10-12 and Table 10-13
Motors and Drives	Motors	N/A	
Motors and Drives	VFD	N/A	
Plug Load	EV charger	N/A	
Plug Load	Network Power Management	N/A	
Plug Load	Office Equipment	N/A	
Plug Load	Smart strip	N/A	
Plug Load	UPS	N/A	
Plug Load	Vending Machine	N/A	
Plug Load	Vending machine controls	N/A	
Process	Air Compressor	N/A	
Refrigeration	Anti-Sweat Heat Control	N/A	
Refrigeration	Case doors	N/A	
Refrigeration	Case light sensor	N/A	

End-Use	Measure Name	PDF method	PDF
Refrigeration	Defrost controls	N/A	
Refrigeration	Door closer	N/A	
Refrigeration	Door gaskets	N/A	
Refrigeration	Evaporator fan control	N/A	
Refrigeration	Evaporator fan EC motor	N/A	
Refrigeration	Floating head pressure	N/A	
Refrigeration	LED case lighting	N/A	
Refrigeration	Night covers	1 - day per year ratio	See Table 10-6
Refrigeration	Strip curtains	1 - day per year ratio	See Table 10-6
Refrigeration	System controller	N/A	
Refrigeration	VFD compressor	N/A	
Water heating	Aerators & Showerheads	1 - day per year ratio	See Table 10-6
Water heating	Combi boiler	2 - FLH ratio	See Table 10-9 and Table 10-10
Water heating	Heat pump water heater	1 - day per year ratio	See Table 10-6
Water heating	Pipe insulation	1 - day per year ratio	See Table 10-6
Water heating	PRSV	1 - day per year ratio	See Table 10-6
Water heating	Recirc pump	1 - day per year ratio	See Table 10-6
Water heating	Storage water heater	1 - day per year ratio	See Table 10-6
Water heating	Tankless water heater	1 - day per year ratio	See Table 10-6
Whole Building	Custom	2 - FLH ratio	See Table 10-9 and Table 10-10
Whole Building	Operator training	N/A	

10.2 TYPE 1 – DAYS PER YEAR RATIO

The days per year ratio method is used for non-weather sensitive measures and is defined as follows:

PDF = 1/operating days per year

Note the default value is 365 days per year. Operating days per year for Residential and Commercial/Industrial building types and the associated peak day factor is shown in the Tables below:

Table 10-5 Peak Day Factors for Residential Buildings Using the Day per Year Ratio Method

Building Type	Prototype Operation Description	Operating Days/Wk	Operating Wk/Yr	Holidays	Operating Days/Yr	PDF
Single Family	24/7 – 365 days	7	52	0	365	0.00274
Multifamily Low Rise	24/7 – 365 days	7	52	0	365	0.00274
Multifamily High- Rise	24/7 – 365 days	7	52	0	365	0.00274

Table 10-6 Peak Day Factors for Commercial and Industrial Buildings Using the Day Per Year Ratio

Building Type	Prototype Operation Description	Operating Days/Wk	Operating Wk/Yr	Holidays	Operating Days/Yr	PDF
Agricultural	24/7 – 365 days	7	52	0	365	0.00274
Assembly	Mon-Sun: 8am – 9pm	7	52	10	355	0.002817
Auto	Mon-Sun: 9am – 9pm	7	52	10	355	0.002817
Big Box	Mon-Sun: 10am – 9pm	7	52	10	355	0.002817
Community College	Mon-Fri: 8am – 7pm Sat: 8am – 4pm Sun: closed	6	49	10	284	0.003521
Dormitory	24/7 – 365 days	7	52	10	355	0.002817
Fast Food	Mon-Sun: 6am – 11pm	7	52	10	355	0.002817
Full Service Restaurant	9am – 12am	6	52	10	303	0.003302
Grocery	Mon-Sun: 6am – 10pm	7	52	0	365	0.00274
Hospital	24/7, 365	7	52	0	365	0.00274
Hotel	Rooms: 60% occupied, 40% unoccupied All others: 24 hr / day	7	52	0	365	0.00274
Large Office	Mon-Sat: 9am – 6pm Sun: Unoccupied	6	52	10	303	0.003302
Light Industrial	Mon-Fri: 6am – 6pm Sat Sun: Unoccupied	5	52	10	251	0.003989
Motel	24/7 - 365	7	52	0	365	0.00274
Multi-story Retail	Mon-Sat: 9am – 10pm Sun: 9am – 7pm	7	52	10	355	0.002817

Building Type	Prototype Operation Description	Operating Days/Wk	Operating Wk/Yr	Holidays	Operating Days/Yr	PDF
Primary School	Mon-Fri: 8am – 6pm Sun: 8am – 4pm	6	38	10	218	0.004587
Religious	Mon-Sat: 12pm-6pm Sun: 9am-7pm	7	52	10	355	0.002817
Secondary School	Mon-Fri: 8am – 7pm Sat: 8am – 4pm Sun: closed	6	38	10	218	0.004587
Small Office	Mon-Sat: 9am – 6pm Sun: Unoccupied	6	52	10	303	0.003302
Small Retail	Mon-Sat: 10 – 10 Sun: 10 – 8	7	52	10	355	0.002817
University	Mon-Fri: 8am – 10pm Sat: 8am – 7pm Sun: closed	6	49	10	284	0.003521
Warehouse	Mon-Fri: 7am – 6pm Sat-Sun: Unoccupied	5	52	10	251	0.003989

10.3 TYPE 2 – FULL LOAD HOUR RATIO

The full load hour method is used for weather sensitive measures where the annual savings are expressed as a function of heating equivalent full load hours. The PDF using this method is defined as:

PDF = FLH (peak gas day) / Annual FLH

The heating equivalent full load hours are calculated based on the assumed oversizing fraction at the ASHRAE heating design temperature for each climate zone and the peak gas day average daily temperature. The amount of heating system oversizing is assumed to vary linearly with the difference between the building heating base temperature and the outdoor temperature. The system oversizing and the number of heating equivalent full load hours during the peak gas day are shown in the Table below:

Table 10-7 Full Load Hours during the Peak Gas Day

Parameter	Northern	Central	Pine Barrens	Southwest	Coastal	Statewide Average
ASHRAE 1% Heating Design Temperature	6	7	3	10	14	
Heating base temperature	65	65	65	65	65	

Parameter	Northern	Central	Pine Barrens	Southwest	Coastal	Statewide Average
Peak Gas Design Temperature	-1.4	-1.4	-1.4	-1.4	-1.4	
Oversizing Factor at ASHRAE Design Temperature	1.2	1.2	1.2	1.2	1.2	
Oversizing Factor at Peak Gas Design Temperature	1.07	1.05	1.12	0.99	0.92	
Peak Gas Day Full Load Hours	22.5	22.9	21.4	24.0	24.0	23.0

For example, the PDF for a high school with a VAV system in the Central climate region is calculated as follows:

PDF = FLH (peak gas day) / Annual FLH

= 22.9 / 254

= 0.09

Residential PDFs are defined as shown in the Table below:

Table 10-8 Residential Building PDFs Using the Full Load Hour Method

Facility Type	Northern	Central	Pine Barrens	Southwest	Coastal	Statewide Average
Single Family	0.023446	0.023851	0.022312	0.025	0.025	0.023923
Multi Family Low Rise	0.023446	0.023851	0.022312	0.025	0.025	0.023923
Multi Family High Rise	0.023446	0.023851	0.022312	0.025	0.025	0.023923

The PDFs by commercial building type and climate zone are calculated from the heating full load hours shown in Appendix C: . The PDFs associated with small commercial buildings by climate zone are shown below:

Table 10-9 Small Commercial Building PDFs using the Full Load Hour Method

Facility Type	Northern	Central	Pine Barrens	Southwest	Coastal	SW average
Assembly	0.02906	0.03437	0.03282	0.03413	0.03016	0.03244
Auto repair	0.00943	0.01113	0.01029	0.01148	0.01121	0.01077
Light industrial	0.02157	0.02949	0.02788	0.02775	0.02589	0.02687
Lodging – Motel	0.04320	0.05674	0.05163	0.05894	0.05018	0.05254
Office – small	0.03844	0.05627	0.05021	0.05929	0.05090	0.05109
Other	0.02462	0.03057	0.02889	0.03058	0.02817	0.02883
Religious worship	0.02689	0.03150	0.03016	0.03245	0.03095	0.03050

Facility Type	Northern	Central	Pine Barrens	Southwest	Coastal	SW average
Restaurant – fast food	0.02050	0.02561	0.02482	0.02504	0.02272	0.02396
Restaurant – full service	0.02055	0.02534	0.02420	0.02519	0.02262	0.02380
Retail – big box	0.05236	0.06632	0.06460	0.06699	0.06025	0.06240
Retail – Grocery	0.02203	0.02508	0.02487	0.02407	0.02105	0.02364
Retail – small	0.02940	0.03941	0.03692	0.03971	0.03662	0.03665
School – primary	0.02124	0.02622	0.02521	0.02540	0.02355	0.02460
Warehouse	0.03736	0.04709	0.04432	0.04789	0.04750	0.04500

Table 10-10 Large Commercial Building PDFs using the Full Load Hour Method

Facility Type	HVAC System	Northern	Central	Pine Barrens	Southwest	Coastal	SW average
Dormitory	Fan coil	0.03899	0.05067	0.04547	0.05187	0.04759	0.04736
Community college	CV econ	0.01500	0.01670	0.01549	0.01617	0.01767	0.01635
	CV noecon	0.01680	0.01886	0.01722	0.01787	0.01971	0.01832
	VAV	0.04677	0.05876	0.06401	0.04717	0.06348	0.05596
	Unknown	0.02914	0.03419	0.03357	0.03041	0.03635	0.03303
High school	CV econ	0.02326	0.02413	0.02334	0.02707	0.02400	0.02418
	CV noecon	0.02482	0.02638	0.02538	0.02886	0.02627	0.02624
	VAV	0.06197	0.09023	0.07910	0.07765	0.07338	0.07863
	Unknown	0.04159	0.05013	0.04657	0.05004	0.04595	0.04741
Hospital	CV econ	0.00497	0.00618	0.00534	0.00607	0.00574	0.00577
	CV noecon	0.00476	0.00558	0.00498	0.00647	0.00615	0.00553
	VAV	0.04240	0.06126	0.05741	0.05824	0.05347	0.05512
	Unknown	0.01897	0.02440	0.02189	0.02502	0.02344	0.02295
Hotel	CV econ	0.02071	0.02377	0.02198	0.02282	0.01762	0.02169
	CV noecon	0.02707	0.03211	0.02932	0.03111	0.02419	0.02921
	VAV	0.06579	0.08427	0.07278	0.09111	0.07017	0.07746
	Unknown	0.02346	0.02732	0.02513	0.02632	0.02039	0.02489
Large Office	CV econ	0.00992	0.01097	0.01006	0.01207	0.01075	0.01076
	CV noecon	0.00978	0.01090	0.01000	0.01201	0.01053	0.01065
	VAV	0.05415	0.06252	0.05692	0.08673	0.05746	0.06138
	Unknown	0.03323	0.03765	0.03441	0.04641	0.03555	0.03691

Facility Type	HVAC System	Northern	Central	Pine Barrens	Southwest	Coastal	SW average
Large Retail	CV econ	0.01080	0.01127	0.01055	0.01172	0.01125	0.01116
	CV noecon	0.01127	0.01171	0.01087	0.01205	0.01148	0.01154
	VAV	0.03100	0.03548	0.03388	0.03706	0.03048	0.03375
	Unknown	0.02404	0.02659	0.02517	0.02768	0.02402	0.02565
University	CV econ	0.01645	0.01836	0.01830	0.02045	0.01983	0.01844
	CV noecon	0.01713	0.02066	0.02002	0.02220	0.02210	0.02028
	VAV	0.04307	0.03250	0.06014	0.03071	0.06146	0.03870
	Unknown	0.02900	0.02690	0.03612	0.02700	0.03838	0.02952

10.4 TYPE 3 – HEATING DEGREE-DAY RATIO

The Heating Degree Day Ratio Method is used for weather sensitive measures where the annual savings are expressed as a function of heating degree days. The PDF is define as:

PDF = HDD peak gas day / Annual HDD

Annual degree day data for each of the NJ climate zones along with the daily HDD during the peak day and the associated PDFs are shown in the table below:

Table 10-11 Peak Day Factors Using the Degree Day Ratio Method

	Climate zone					
	Northern	Central	Pine barrens	Southwest	Coastal	SW Average
Annual HDD(65)	4,049	3,971	3,756	3,930	3,484	3,878
Gas Peak Day HDD(65)	66.4	66.4	66.4	66.4	66.4	66.4
PDF	0.016398	0.016723	0.017676	0.016896	0.01906	0.017122

10.5 TYPE 4 – HOURS PER YEAR RATIO

The hours per year ratio method is based on the ratio of the number of heating system operating hours during the peak gas day to the annual number of heating system operating hours. This method is used to calculate PDFs for HVAC interactive effects of lighting or other internal loads on heating energy. The PDF is defined as:

PDF = 24 / annual heating hr per year

Heating system operating hours by building type and climate zone are shown in the Tables below:

Table 10-12 Heating System Operating Hours and Peak Day Factors for Small Commercial Buildings

Building	Climate	Heating Hours	PDF
Assembly	Central	3,741	0.006415
Assembly	Coastal	3,847	0.006239
Assembly	Northern	4,039	0.005942
Assembly	Pine Barrens	3,674	0.006532
Assembly	Southwest	3,687	0.006509
Assembly	Statewide Average	3,795	0.006324
Auto repair	Central	4,377	0.005483
Auto repair	Coastal	4,463	0.005378
Auto repair	Northern	4,683	0.005125
Auto repair	Pine Barrens	4,296	0.005587
Auto repair	Southwest	4,302	0.005579
Auto repair	Statewide Average	4,426	0.005423
Big box	Central	2,725	0.008807
Big box	Coastal	2,729	0.008794
Big box	Northern	2,963	0.0081
Big box	Pine Barrens	2,696	0.008902
Big box	Southwest	2,697	0.008899
Big box	Statewide Average	2,760	0.008696
Fast food restaurant	Central	3,958	0.006064
Fast food restaurant	Coastal	4,025	0.005963
Fast food restaurant	Northern	4,210	0.005701
Fast food restaurant	Pine Barrens	3,845	0.006242
Fast food restaurant	Southwest	3,895	0.006162
Fast food restaurant	Statewide Average	3,992	0.006012
Full service restaurant	Central	3,614	0.006641
Full service restaurant	Coastal	3,693	0.006499
Full service restaurant	Northern	3,931	0.006105
Full service restaurant	Pine Barrens	3,551	0.006759
Full service restaurant	Southwest	3,588	0.006689
Full service restaurant	Statewide Average	3,671	0.006538
Grocery	Central	8,760	0.00274

Building	Climate	Heating Hours	PDF
Grocery	Coastal	8,760	0.00274
Grocery	Northern	8,760	0.00274
Grocery	Pine Barrens	8,760	0.00274
Grocery	Southwest	8,760	0.00274
Grocery	Statewide Average	8,760	0.00274
Light industrial	Central	2,596	0.009245
Light industrial	Coastal	2,781	0.00863
Light industrial	Northern	3,044	0.007884
Light industrial	Pine Barrens	2,571	0.009335
Light industrial	Southwest	2,706	0.008869
Light industrial	Statewide Average	2,711	0.008852
Motel	Central	2,216	0.01083
Motel	Coastal	2,239	0.010719
Motel	Northern	2,325	0.010323
Motel	Pine Barrens	2,181	0.011004
Motel	Southwest	2,188	0.010969
Motel	Statewide Average	2,231	0.010756
Primary school	Central	4,104	0.005848
Primary school	Coastal	4,229	0.005675
Primary school	Northern	4,432	0.005415
Primary school	Pine Barrens	4,045	0.005933
Primary school	Southwest	4,081	0.005881
Primary school	Statewide Average	4,171	0.005754
Religious	Central	1,915	0.012533
Religious	Coastal	1,934	0.01241
Religious	Northern	1,957	0.012264
Religious	Pine Barrens	1,835	0.013079
Religious	Southwest	1,877	0.012786
Religious	Statewide Average	1,912	0.012551
Small office	Central	2,456	0.009772
Small office	Coastal	2,567	0.009349
Small office	Northern	2,916	0.00823

Building	Climate	Heating Hours	PDF
Small office	Pine Barrens	2,391	0.010038
Small office	Southwest	2,482	0.00967
Small office	Statewide Average	2,548	0.00942
Small retail	Central	3,169	0.007573
Small retail	Coastal	3,304	0.007264
Small retail	Northern	3,544	0.006772
Small retail	Pine Barrens	3,118	0.007697
Small retail	Southwest	3,196	0.007509
Small retail	Statewide Average	3,252	0.007381
Warehouse	Central	1,521	0.015779
Warehouse	Coastal	1,610	0.014907
Warehouse	Northern	1,672	0.014354
Warehouse	Pine Barrens	1,489	0.016118
Warehouse	Southwest	1,548	0.015504
Warehouse	Statewide Average	1,560	0.015381

Table 10-13 Heating System Operating Hours and Peak Day Factors for Large Commercial buildings

Building	System	Climate	Heating hours	PDF
Community College	Any	Statewide Average	3,364	0.007135
Dorm	Any	Statewide Average	3,824	0.006276
Hospital	Any	Statewide Average	8,756	0.002741
Hotel	Any	Statewide Average	8,665	0.00277
High School	Any	Statewide Average	1,947	0.01233
Large Office	Any	Statewide Average	5,516	0.004351
Large Retail	Any	Statewide Average	4,540	0.005287
University	Any	Statewide Average	3,833	0.006262

11 APPENDIX H: NET-TO-GROSS FACTORS

11.1 COMMERCIAL NTG

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Auto Milker Takeoff	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Dairy Scroll Compressor	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
HE Ventilation Fans	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Heat Reclaimers	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
High Volume Low Speed Fans (Destratification)	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Livestock Waterer	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Dairy Vac Pump VSD Controls	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Low Pressure Irrigation	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Dairy Refrigeration Tune-Up	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Engine Block Heater Timer	Agriculture	Agriculture	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Building Operations Training	General	Building Operations Training	Electric	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Building Operations Training	General	Building Operations Training	Natural Gas	Down-stream	0.95	0.95	0.95	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Building Tune Up	General	Building Tune Up	Natural Gas	Down-stream	0.96	0.96	0.96	Median of 2 RCx gas program values from literature review	9. Program Level Same Delivery Mode	None
Building Tune Up	General	Building Tune Up	Electric	Down-stream	0.75	0.75	0.75	Median of 3 electric RCx program valuess from literature review	9. Program Level Same Delivery Mode	None
Air-Cooled Chiller with Condenser	HVAC	Chillers	Electric	Down-stream	0.77	0.77	0.77	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Water-Cooled Screw Chiller & Reciprocating Chillers	HVAC	Chillers	Electric	Down-stream	0.77	0.77	0.77	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Water-Cooled Centrifugal Chillers	HVAC	Chillers	Electric	Down-stream	0.77	0.77	0.77	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Air-Cooled Chiller with Condenser	HVAC	Chillers with a VFD	Electric	Down-stream	0.77	0.77	0.77	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Water-Cooled Screw and Reciprocating Chillers	HVAC	Chillers with a VFD	Electric	Down-stream	0.77	0.77	0.77	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Water-Cooled Centrifugal Chillers	HVAC	Chillers with a VFD	Electric	Down-stream	0.77	0.77	0.77	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Gas Absorption Chillers, < 100 tons	HVAC	Chillers with a VFD	Natural Gas	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Gas Absorption Chillers, > 400 tons	HVAC	Chillers with a VFD	Natural Gas	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Gas Absorption Chillers, 100 to 400 tons	HVAC	Chillers with a VFD	Natural Gas	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Gas Engine Driven Chillers	HVAC	Chillers with a VFD	Natural Gas	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Gas Fired Low Intensity Infrared Heating <100MBH	HVAC	Chillers with a VFD	Natural Gas	Down-stream	0.64	0.64	0.64	Median of 2 programs with non-specific gas heating measures values from literature review	6. Similar Measure All Delivery Modes	None
Gas Fired Low Intensity Infrared Heating >100MBH	HVAC	Chillers with a VFD	Natural Gas	Down-stream	0.64	0.64	0.64	Median of 2 programs with non-specific gas heating measures values from literature review	6. Similar Measure All Delivery Modes	None
Clotheswasher CEE Tier 1	Appliances	Clotheswasher	Electric	Down-stream	0.51	0.51	0.51	Median of 3 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Clotheswasher CEE Tier 2	Appliances	Clotheswasher	Electric	Down-stream	0.51	0.51	0.51	Median of 3 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Convection Ovens	Kitchen Equipment	Combination and Convection Ovens	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Combination Ovens	Kitchen Equipment	Combination and Convection Ovens	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Combination Oven/Steamer	Kitchen Equipment	Combination and Convection Ovens	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Conveyor Oven	Kitchen Equipment	Combination and Convection Ovens	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Dishwasher, Under Counter	Kitchen Equipment	Commercial Dishwashers	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Dishwasher, Door Type	Kitchen Equipment	Commercial Dishwashers	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Dishwasher, Single Tank Conveyor	Kitchen Equipment	Commercial Dishwashers	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Dishwasher, Multi Tank Conveyor	Kitchen Equipment	Commercial Dishwashers	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Door Type High Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Door Type Low Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Multiple Tank Conveyor, High Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Multiple Tank Conveyor, Low Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Single Tank Conveyor, High Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Single Tank Conveyor, Low Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Commercial Dishwashers, Under Counter High Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Dishwashers, Under Counter Low Temp	Kitchen Equipment	Commercial Dishwashers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Food Service - Midstream	Kitchen Equipment	Commercial Kitchen Equipment	Electric	Midstream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Food Service - Midstream	Kitchen Equipment	Commercial Kitchen Equipment	Natural Gas	Midstream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Prescriptive Compressed Air Measures	General	Compressed Air	Electric	Down-stream	0.88	0.88	0.88	Median of 3 values from literature review for retrofit prescriptve programs with compressed air measure offerings	9. Program Level Same Delivery Mode	None
Fat Fryers (Electric)	Kitchen Equipment	Cooking Equipment	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Griddles (Electric)	Kitchen Equipment	Cooking Equipment	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Insulated Holding Cabinets	Kitchen Equipment	Cooking Equipment	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Fryer (Gas)	Kitchen Equipment	Cooking Equipment	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Griddle (Gas)	Kitchen Equipment	Cooking Equipment	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Commercial Rack Oven (Gas)	Kitchen Equipment	Cooking Equipment	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Compressed Air, Refrigeration, Data Center Equipment/Servers, HVAC/Chillers, HVAC Controls, Motors/VFD - Large, Building Improvements, Process Improvements, Agricultural Lighting/Process, Custom Lighting	General	Custom	Natural Gas	Down-stream	see measure group break outs	see measure group break outs	see measure group break outs			
Compressed Air, Refrigeration, Data Center Equipment/Servers, HVAC/Chillers, HVAC Controls, Motors/VFD - Large, Building Improvements, Process Improvements, Agricultural Lighting/Process, Custom Lighting	General	Custom	Electric	Down-stream	see measure group break outs	see measure group break outs	see measure group break outs			
Custom - Building Improvements	General	Custom	Natural Gas	Down-stream	0.82	0.82	0.82	Median of 4 custom gas downstream retrofit program values from literature review	4. Multiple Directly Comparable Sources	None
Custom - Water Heating	Waterheating	Custom	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 3 downstream custom program values from literature review	5. Similar Measure & Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Custom - Water Heating	Waterheating	Custom	Electric	Down-stream	0.71	0.71	0.71	Median of 3 downstream custom program values from literature review	5. Similar Measure & Delivery Mode	None
Custom - HVAC	HVAC	Custom	Natural Gas	Down-stream	0.82	0.82	0.82	Median of 4 custom gas downstream retrofit program values from literature review	4. Multiple Directly Comparable Sources	None
Custom - HVAC	HVAC	Custom	Electric	Down-stream	0.77	0.77	0.77	Median of 9 custom program values from literature review	4. Multiple Directly Comparable Sources	None
Custom - Other	General	Custom	Natural Gas	Down-stream	0.82	0.82	0.82	Median of 4 custom gas downstream retrofit program values from literature review	4. Multiple Directly Comparable Sources	None
Custom - Other	General	Custom	Electric	Down-stream	0.77	0.77	0.77	Median of 9 custom program values from literature review	4. Multiple Directly Comparable Sources	None
Custom - Lighting	Lighting	Custom	Electric	Down-stream	0.53	0.48	0.43	Median of 75 values from literature review	4. Multiple Directly Comparable Sources	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Daylight continuous dimming control	Lighting	Daylight Controls	Electric	Down-stream	0.69	0.66	0.63	Median of 9 lighting system control values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Demand Controlled Kitchen Ventilation (DCKV)	Kitchen Equipment	Demand Controlled Kitchen Ventilation (DCKV)	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Modulating Gas Dryer Valve	Appliances	Dryer Valve	Natural Gas		0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Dual daylight & occupancy sensor (DOS)	Lighting	Dual Daylight/Occupancy Controls	Electric	Down-stream	0.69	0.66	0.63	Median of 9 lighting system control values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless, Mini Split Air Conditioners or Heat Pumps - All Sizes	HVAC	Ductless, Mini Split Air Conditioners or Heat Pumps - All Sizes	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
ECM <1 HP	Motors	ECM Motors	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
ECM 1 HP	Motors	ECM Motors	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
ECM 2 HP	Motors	ECM Motors	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
ECM 3-5 HP	Motors	ECM Motors	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
ECM 6-10 HP	Motors	ECM Motors	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
ECM 11+ HP	Motors	ECM Motors	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
Electric Vehicle Charger	Plug Loads	Electric Vehicle Chargers	Electric	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Geothermal Heat Pumps – (Ground Source/Ground Water Source)	HVAC	Geothermal Heat Pumps - All Sizes	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Glass Door Reach-in Refrigerators	Kitchen Equipment	Glass Door Reach-In	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Glass Door Reach-in Freezers	Kitchen Equipment	Glass Door Reach-In	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Hotel Room HVAC Controls	Plug Loads	Hotel Room Controls	Electric	Down-stream	0.80	0.80	0.80	Median of 2 values from literature review	7. Partial Measure Group	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
Hotel Room HVAC/Receptacle Control	Plug Loads	Hotel Room Controls	Electric	Down-stream	0.80	0.80	0.80	Median of 2 values from literature review	7. Partial Measure Group	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
HVAC - Midstream	HVAC	HVAC - Midstream	Electric	Midstream	0.63	0.63	0.63	Median of 5 values from literature review	9. Program Level Same Delivery Mode	None
90% TE Make-up Air Unit	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.64	0.64	0.64	Median of 2 programs with non-specific gas heating measures values from literature review	6. Similar Measure All Delivery Modes	None
Gas Furnace > 95% AFUE	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Gas Furnace > 97% AFUE	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler HW Non-condensing, < 300 MBh (85% AFUE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
								programs with boiler related measures		
Boiler HW Non-condensing, 300 to 2,500 MBh (85% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler HW Non-condensing, > 2,500 MBh (85% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler Tune-up	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 3 values from literature review for programs with boiler tune-up measures	9. Program Level Same Delivery Mode	g. 10% Decrease Due to Common Nature of Measure
Boiler w/Reset Controls	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, HW Condensing - Tier 1, < 300 MBh (>90% AFUE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, HW Condensing - Tier 1, 300 to 2,500 MBh (88%TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, HW Condensing - Tier 1, > 2,500 MBh (88% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, HW Condensing - Tier 2, < 300 MBh (>95% AFUE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Boiler, HW Condensing - Tier 2, 300 to 2,500 MBh (>94% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, HW Condensing - Tier 2, > 2,500 MBh (>81%TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, Steam < 300 MBH Input (82% AFUE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, Steam All Except Natural Draft, > 2,500 MBh (81% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, Steam All Except Natural Draft, 300 to 2,500 MBh (81% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, Steam Natural Draft, < 300 to 2,500 MBh (81% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler, Steam Natural Draft, > 2,500 MBh (81% TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Condensing Integrated Boiler and Water Heater (<300MBH,90 AFUE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Condensing Integrated Boiler and Water Heater (>300MBH, 94TE)	HVAC	HVAC - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Ice Machine, Tier 1	Kitchen Equipment	Ice Machines	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Ice Machine, Tier 2	Kitchen Equipment	Ice Machines	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
New LED display case luminaire, including refrigerator/freezer display	Lighting	LED Display Case Luminaires	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
New LED ENERGY STAR LED fixture - meant to replace A-Line, PAR, R, G, MR, and other specialty[159] type lamps	Lighting	LED ENERGY STAR Fixtures	Electric	Down-stream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
New LED ENERGY STAR LED fixture - meant to replace OTHER THAN A-Line, PAR, R, G, MR, and other specialty type lamps	Lighting	LED ENERGY STAR Fixtures	Electric	Down-stream	0.53	0.48	0.43	Median of 75 values from literature review	4. Multiple Directly Comparable Sources	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
New LED luminaire - wall packs, flood lights, canopy, landscape	Lighting	LED Exterior Luminaires	Electric	Down-stream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends

[159] NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
New LED flat panel for 2x2, 1x4 and 2x4 luminaires	Lighting	LED Flat Panel Luminaires	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
New LED high/low bay luminaire	Lighting	LED High/Low Bay Luminaires	Electric	Down-stream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
New LED wall wash luminaire	Lighting	LED Interior Directional Luminaires	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
New LED track/mono-point luminaire[160]	Lighting	LED Interior Directional Luminaires	Electric	Down-stream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
New LED linear ambient luminaire	Lighting	LED Linear Ambient/Stairwell Luminaires	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
New LED stairwell luminaire	Lighting	LED Linear Ambient/Stairwell Luminaires	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
LED linear replacement lamp with new LED driver for wall pack, flood light, canopy, recessed fixture.	Lighting	LED Replacement Lamps	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
LED mogul-screw base replacement for HID lamps and new external driver	Lighting	LED Replacement Lamps	Electric	Down-stream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends

[160] NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
LED lamps - A-Line, PAR, R, G, MR, and other specialty type lamps[161]	Lighting	LED Replacement Lamps	Electric	Down-stream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Replacement Lamps 2' - 8' (Type A, B 7 AB)	Lighting	LED Replacement Lamps	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
LED linear retrofit kit for 2x2, 1x4 and 2x4 fixtures	Lighting	LED Retrofit Kits	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
LED integrated retrofit kit for 2x2, 1x4 and 2x4 fixtures	Lighting	LED Retrofit Kits	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
LED retrofit kit for linear ambient luminaire	Lighting	LED Retrofit Kits	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
LED retrofit kit for high/low bay luminaires	Lighting	LED Retrofit Kits	Electric	Down-stream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
LED retrofit kit for exterior luminaire	Lighting	LED Retrofit Kits	Electric	Down-stream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
LED retrofit kit for recessed downlight[162]	Lighting	LED Retrofit Kits	Electric	Down-stream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
Exterior/Dusk-to-Dawn, Interior and 24 hour application	Lighting	LED Sign Lighting	Electric	Down-stream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid

[161] NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf
[162] NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
										Commercialization; i: Broad Market Trends
New LED linear recessed troffer/panel for 2x2, 1x4 and 2x4 luminaires	Lighting	LED Troffer Luminaires	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Multifamily - Unless otherwise specified		Multifamily Common Areas			See Method	See Method	See Method	Apply Residential NTG Ratios to In-Unit Measures and Commercial NTG Ratios to Common Area Measures		
Networked lighting control system controlling efficient luminaires	Lighting	Networked Lighting Controls	Electric	Down-stream	0.69	0.66	0.63	Median of 9 lighting system control values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Networked lighting control - fixture level control	Lighting	Networked Lighting Controls	Electric	Down-stream	0.69	0.66	0.63	Median of 9 lighting system control values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Personal Occupancy Sensor	Plug Loads	Occupancy Sensor	Electric	Down-stream	0.80	0.80	0.80	Median of 35 downstream prescriptive program values from literature review	9. Program Level Same Delivery Mode	None
Vacancy or Occupancy control (Switch/Wall/External Mount)	Lighting	Occupancy/Vacancy Controls	Electric	Down-stream	0.62	0.59	0.56	Median of 9 fixture based control system values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Vacancy or Occupancy control (Integrated)	Lighting	Occupancy/Vacancy Controls	Electric	Down-stream	0.69	0.66	0.63	Median of 9 lighting system control values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Monitors - C&I	Office	Office Equipment	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	h. National Shipment Data
Computers - C&I	Office	Office Equipment	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	h. National Shipment Data
Uninterruptible Power Supply (UPS)	Office	Office Equipment	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	h. National Shipment Data

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Imaging - C&I	Office	Office Equipment	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	h. National Shipment Data
Small Network PC Controller	Office	Office Equipment	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	h. National Shipment Data
Energy Star Beverage Vending Machine	Kitchen Equipment	Other Food Service	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Food Warmers/Rethermalizer Well/Coffee Pots	Kitchen Equipment	Other Food Service	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Pre-Rinse Spray Valve	Kitchen Equipment	Other Food Service	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Pre-Rinse Spray Valve	Kitchen Equipment	Other Food Service	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Thermostat - Smart	HVAC	Other HVAC Equipment	Electric	Down-stream	0.82	0.79	0.76	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Thermostat - Smart	HVAC	Other HVAC Equipment	Natural Gas	Down-stream	0.80	0.77	0.74	Median of 3 values from literature review for programs with HVAC controls measures	9. Program Level Same Delivery Mode	g. 10% Decrease Due to Common Nature of Measure; e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Dual Enthalpy Economizer Controls, unspecified	HVAC	Other HVAC Equipment	Electric	Down-stream	0.86	0.86	0.86	Median of 2 values from literature review	5. Similar Measure & Delivery Mode	None
Dual Enthalpy Economizer Controls, < 5 tons	HVAC	Other HVAC Equipment	Electric	Down-stream	0.86	0.86	0.86	Median of 2 values from literature review	5. Similar Measure & Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Dual Enthalpy Economizer Controls, > 5 tons	HVAC	Other HVAC Equipment	Electric	Down-stream	0.86	0.86	0.86	Median of 2 values from literature review	5. Similar Measure & Delivery Mode	None
Demand Control Ventilation	HVAC	Other HVAC Equipment	Electric	Down-stream	0.86	0.86	0.86	Median of 2 values from literature review	5. Similar Measure & Delivery Mode	None
Boiler Economizer Controls, < 800,000 Btu	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler Economizer Controls, > 4 MMBtu	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler Economizer Controls, 0.8 to 1.6 MMBtu	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler Economizer Controls, 1.6 to 3 MMBtu	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler Economizer Controls, 3 to 3.5 MMBtu	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
Boiler Economizer Controls, 3.5 to 4 MMBtu	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None
HW Recirculating System with demand control	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 5 values from literature review for programs with boiler related measures	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Ventilation with Heat Recovery Gas HRV	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.64	0.64	0.64	Median of 2 programs with non-specific gas heating measures values from literature review	6. Similar Measure All Delivery Modes	None
Ventilation with Heat Recovery Gas ERV	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.64	0.64	0.64	Median of 2 programs with non-specific gas heating measures values from literature review	6. Similar Measure All Delivery Modes	None
Boiler Tune-up	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 3 values from literature review for programs with boiler tune-up measures	9. Program Level Same Delivery Mode	g. 10% Decrease Due to Common Nature of Measure
Furnace Tune-up	HVAC	Other HVAC Equipment - Natural Gas	Natural Gas	Down-stream	0.84	0.84	0.84	Median of 3 values from literature review for programs with boiler tune-up measures	9. Program Level Same Delivery Mode	g. 10% Decrease Due to Common Nature of Measure
Exit Signs	Lighting	Other Lighting	Electric	Down-stream	0.53	0.48	0.43	Median of 75 values from literature review	4. Multiple Directly Comparable Sources	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Linear Fluorescent HE T8	Lighting	Other Lighting	Electric	Down-stream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Street/Roadway and Area Lighting	Lighting	Other Lighting	Electric	Down-stream	0.75	0.75	0.75	Median of 2 values in literature review	8. Full Measure Group	None
Horticultural Lighting (Controlled Environment Agriculture)	Lighting	Other Lighting	Electric	Down-stream	0.53	0.48	0.43	Median of 75 values from literature review	4. Multiple Directly Comparable Sources	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Delamping	Lighting	Other Lighting	Electric	Down-stream	0.53	0.48	0.43	Median of 75 values from literature review	4. Multiple Directly Comparable Sources	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Lighting - Midstream Linear Types (TLEDs, luminaires meant to replace linears)	Lighting	Other Lighting	Electric	Midstream	0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Lighting - Midstream LED Lamps A-Line, PAR, R, G, MR, and other specialty type lamps[163]	Lighting	Other Lighting	Electric	Midstream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
Lighting - Midstream High/Low Bay	Lighting	Other Lighting	Electric	Midstream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
Lighting - Midstream Exterior	Lighting	Other Lighting	Electric	Midstream	0.64	0.59	0.54	Evaluator assigned relative to the linear value of 63%	10. Evaluator Assigned	b. 10% Strong Program Impacts Boost; f: Annual Decrease (5 percentage points) Due to Rapid Commercialization; i: Broad Market Trends
Lighting - Midstream networked lighting controls system	Lighting	Other Lighting	Electric	Midstream	0.69	0.66	0.63	Median of 9 lighting system control values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Lighting - Midstream Networked lighting controls fixture level	Lighting	Other Lighting	Electric	Midstream	0.69	0.66	0.63	Median of 9 fixture based control system values from literature review	6. Similar Measure All Delivery Modes	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Packaged Terminal Air Conditioners or Heat Pumps - All Sizes	HVAC	Packaged Terminal Air Conditioners or Heat Pumps - All Sizes	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Power Strip - Tier 1	Plug Loads	Power Strip	Electric	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends

[163] NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Power Strip - Tier 2	Plug Loads	Power Strip	Electric	Down-stream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	i. Broad Market Trends
Refrigerator Recycling	Early Retirement / Recycling	Recycling	Electric	Down-stream	0.51	0.51	0.51	Median of 19 values from literature	5. Similar Measure & Delivery Mode	None
Freezer Recycling	Early Retirement / Recycling	Recycling	Electric	Down-stream	0.58	0.58	0.58	Median of 14 values from literature	6. Similar Measure All Delivery Modes	None
Room A/C Unit Recycling	Early Retirement / Recycling	Recycling	Electric	Down-stream	0.50	0.50	0.50	Median of 6 values from literature	5. Similar Measure & Delivery Mode	None
Dehumidifier Recycling	Early Retirement / Recycling	Recycling	Electric	Down-stream	0.41	0.41	0.41	Median of 7 values from literature	5. Similar Measure & Delivery Mode	None
Anti-Fog Film	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Anti-Sweat Heat Control	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
ECM Evaporator Fan Motor, <1 hp	Refrigeration	Refrigeration	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None
Evaporator/Compressor Controller	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Evaporator Fan Controller on Existing Shaded-Pole Motor	Refrigeration	Refrigeration	Electric	Down-stream	0.75	0.75	0.75	Median of 4 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Night Covers - Open Reach-In Coolers	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Reach-In Door Closer	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Refrigeration Display Case Doors on Open Display Case	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Gaskets	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Strip Curtains for Walk-In Coolers and Freezers	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Refrigerator Case Light Sensor	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Floating Head Pressure Controls	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Variable Speed Refrigeration Compressor	Refrigeration	Refrigeration	Electric	Down-stream	0.93	0.93	0.93	Median of 2 values from literature review	4. Multiple Directly Comparable Sources	None
Clothes Washer Tier 1	Appliances	Residential Appliances in C&I	Natural Gas	Down-stream	0.51	0.51	0.51	Median of 3 values from literature	4. Multiple Directly	a. Removed Outliers

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
		Building - Non Commercial Duty							Comparable Sources	
Clothes Washer Tier 2	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Natural Gas	Down-stream	0.51	0.51	0.51	Median of 3 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Clothes Dryer - Tier 1	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Clothes Dryer - Tier 1	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Natural Gas	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Clothes Dryer - Tier 2	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Clothes Dryer - Tier 2	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Natural Gas	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Refrigerators Tier 1	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.47	0.47	0.47	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Refrigerators Tier 2	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.47	0.47	0.47	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Freezer	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.52	0.52	0.52	Median of 26 kitchen and laundry appliance values in literature	7. Partial Measure Group	a. Removed Outliers

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Dehumidifier	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.49	0.49	0.49	Median of 12 values from literature	4. Multiple Directly Comparable Sources	None
Room Air Conditioner	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.54	0.54	0.54	Median of 9 values from literature	4. Multiple Directly Comparable Sources	None
Water Cooler	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Electric	Down-stream	0.52	0.52	0.52	Median of 26 kitchen and laundry appliance values in literature	7. Partial Measure Group	a. Removed Outliers
Indoor Pool Cover	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Natural Gas		0.80	0.80	0.80	Median of 35 downstream prescriptive program values from literature review	9. Program Level Same Delivery Mode	None
Outdoor Pool Cover	Appliances	Residential Appliances in C&I Building - Non Commercial Duty	Natural Gas		0.80	0.80	0.80	Median of 35 downstream prescriptive program values from literature review	9. Program Level Same Delivery Mode	None
Retrocommissioning Single compressor units	General	Retrocommissioning (including Virtual and Meter Data Commissioning)	Electric	Down-stream	0.75	0.75	0.75	Median of 3 electric RCx program valuess from literature review	9. Program Level Same Delivery Mode	None
Retrocommissioning Multiple compressor units	General	Retrocommissioning (including Virtual and Meter Data Commissioning)	Electric	Down-stream	0.75	0.75	0.75	Median of 3 electric RCx program valuess from literature review	9. Program Level Same Delivery Mode	None
Retrocommissioning PTAC, PTHP, MiniSplits	General	Retrocommissioning (including Virtual and Meter Data Commissioning)	Electric	Down-stream	0.75	0.75	0.75	Median of 3 electric RCx program valuess from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Retrocommissioning (including Virtual and Meter Data Commissioning)	General	Retrocommissioning (including Virtual and Meter Data Commissioning)	Electric	Down-stream	0.75	0.75	0.75	Median of 3 electric RCx program valuess from literature review	9. Program Level Same Delivery Mode	None
Retrocommissioning (including Virtual and Meter Data Commissioning)	General	Retrocommissioning (including Virtual and Meter Data Commissioning), Custom	Natural Gas	Down-stream	0.96	0.96	0.96	Median of 2 RCx gas program values from literature review	9. Program Level Same Delivery Mode	None
Retrocommissioning (including Virtual and Meter Data Commissioning)	General	Retrocommissioning (including Virtual and Meter Data Commissioning), Custom	Electric	Down-stream	0.75	0.75	0.75	Median of 3 electric RCx program valuess from literature review	9. Program Level Same Delivery Mode	None
SBDI - Unitary HVAC/Split Systems and Single Package, Air Cooled	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Air-Air Cooled Heat Pump Systems, Split System and Single Package	HVAC	SBDI Measures	Electric	Direct Install	0.88	0.85	0.82	Median of 9 values from literature review	9. Program Level Same Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
SBDI - Water Source Heat Pumps	HVAC	SBDI Measures	Electric	Direct Install	0.88	0.85	0.82	Median of 9 values from literature review	9. Program Level Same Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
SBDI - Furnace High Efficiency Fan	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Solar Domestic Hot Water (augmenting electric resistance DHW)	Waterheating	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
SBDI - Heat Pump Hot Water (HPHW)	Waterheating	SBDI Measures	Electric	Direct Install	0.88	0.85	0.82	Median of 9 values from literature review	9. Program Level Same Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
SBDI - Drain Water Heat Recovery (DWHR)	Waterheating	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Motors	Motors	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Variable Frequency Drives	VFD / Drives	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Walk-in Cooler/Freezer Evaporator Fan Control	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Cooler and Freezer Door Heater Control	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Electric Defrost Control	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Aluminum Night Covers	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Novelty Cooler Shutoff	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Energy Efficient Glass Doors on Open Refrigerated Cases	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - ECM on Evaporator Fans	Refrigeration	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
SBDI - Refrigerated Vending Machine Control	Kitchen Equipment	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Refrigerated Case LED Lighting (Prescriptive Lighting)	Kitchen Equipment	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Vending Machine Controls	Kitchen Equipment	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Stand Alone Storage Water Heaters	Waterheating	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Instantaneous Water Heaters	Waterheating	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Boilers	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Small Commercial Boilers	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Gas Furnaces	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Infrared Heating	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Programmable Thermostats	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Programmable Thermostats	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
SBDI - Boiler Reset Controls	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Dual Enthalpy Economizers	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Electronic Fuel-Use Economizers (Boilers, Furnaces, AC)	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Electronic Fuel-Use Economizers (Boilers, Furnaces, AC)	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Demand-Controlled Ventilation Using CO2 Sensors	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Demand-Controlled Ventilation Using CO2 Sensors	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Low Flow Faucet Aerators and Showerheads	Waterheating	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Low Flow Faucet Aerators and Showerheads	Waterheating	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Low Flow Pre-rinse Spray Valves	Waterheating	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Low Flow Pre-rinse Spray Valves	Waterheating	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Pipe Insulation	Waterheating	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
SBDI - Pipe Insulation	Waterheating	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Prescriptive Lighting - OTHER THAN LED Lamps A-Line, PAR, R, G, MR, and other specialty type lamps	Lighting	SBDI Measures	Electric	Direct Install	0.76	0.71	0.66	Median of 16 prescriptive lighting values from literature review	6. Similar Measure All Delivery Modes	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
SBDI - Prescriptive Lighting LED Lamps A-Line, PAR, R, G, MR, and other specialty type lamps	Lighting	SBDI Measures	Electric	Direct Install	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
SBDI - Lighting Controls (Occupancy Sensors, High-Bay Occupancy Sensors, Photocell with Dimmable Ballast)	Lighting	SBDI Measures	Electric	Direct Install	0.76	0.71	0.66	Median of 16 prescriptive lighting values from literature review	6. Similar Measure All Delivery Modes	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
SBDI - Smart Thermostat	HVAC	SBDI Measures	Natural Gas	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
SBDI - Smart Thermostat	HVAC	SBDI Measures	Electric	Direct Install	0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Stack Economizer for Boilers	HVAC	SBDI Measures	Natural Gas		0.91	0.91	0.91	Median of 9 values from literature review	9. Program Level Same Delivery Mode	None
Solid Door Reach-in Refrigerators	Kitchen Equipment	Solid Door Reach-In	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Solid Door Reach-in Freezers	Kitchen Equipment	Solid Door Reach-In	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Steam Cookers, unspecified	Kitchen Equipment	Steam Cookers	Electric	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Commercial Steam Cooker	Kitchen Equipment	Steam Cookers	Natural Gas	Down-stream	0.81	0.81	0.81	Median of 9 food services program value from literature review	9. Program Level Same Delivery Mode	None
Air Conditioning (AC) only - Split or Packaged, Tier 1 SEER 16	HVAC	Unitary - Air Conditioners & Heat Pumps, < 5.4 tons (65,000 BTU/hr)	Electric	Down-stream	0.93	0.93	0.93	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	None
Air Conditioning (AC) only - Split or Packaged, Tier 2 SEER 18	HVAC	Unitary - Air Conditioners & Heat Pumps, < 5.4 tons (65,000 BTU/hr)	Electric	Down-stream	0.93	0.93	0.93	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	None
Heat Pumps - Split or Packaged, Tier 1 SEER 16 EER 13 HSPF 10	HVAC	Unitary - Air Conditioners & Heat Pumps, < 5.4 tons (65,000 BTU/hr)	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Heat Pumps - Split or Packaged, Tier 2 SEER 18 EER 13 HSPF 10	HVAC	Unitary - Air Conditioners & Heat Pumps, < 5.4 tons (65,000 BTU/hr)	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Conditioning (AC) only - Split or Packaged	HVAC	Unitary - Air Conditioners & Heat Pumps, > 5.4 tons (65,000 BTU/hr)	Electric	Down-stream	0.93	0.93	0.93	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	None
Heat Pumps - Air Source - Split or Packaged	HVAC	Unitary - Air Conditioners & Heat Pumps, > 5.4 tons (65,000 BTU/hr)	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Central DX Air Conditioners - All Sizes	HVAC	Unitary - Air Conditioners & Heat Pumps, Central DX	Electric	Down-stream	0.93	0.93	0.93	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
		Air Conditioners- All Sizes								
Single Package Vertical Air Conditioner - ALL SIZES	HVAC	Unitary - Air Conditioners & Heat Pumps, Single Package Vertical	Electric	Down-stream	0.93	0.93	0.93	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	None
Single Package Vertical Heat Pump - ALL SIZES	HVAC	Unitary - Air Conditioners & Heat Pumps, Single Package Vertical	Electric	Down-stream	0.83	0.80	0.77	Median of 2 HP specific program values from literature review	5. Similar Measure & Delivery Mode	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Vending machine controls, Non-Refrigerated	Plug Loads	Vending Machine Controls	Electric	Down-stream	0.77	0.77	0.77	Median of 2 values from literature review	9. Program Level Same Delivery Mode	g. 10% Decrease Due to Common Nature of Measure
Vending machine controls, Refrigerated	Plug Loads	Vending Machine Controls	Electric	Down-stream	0.77	0.77	0.77	Median of 2 values from literature review	9. Program Level Same Delivery Mode	g. 10% Decrease Due to Common Nature of Measure
VFD < 100 hp	VFD / Drives	VFD - Variable Frequency Drives	Electric	Down-stream	0.65	0.65	0.65	Median of 8 values from literature review	9. Program Level Same Delivery Mode	None
VFD >100 to <200	VFD / Drives	VFD - Variable Frequency Drives	Electric	Down-stream	0.65	0.65	0.65	Median of 8 values from literature review	9. Program Level Same Delivery Mode	None
Water-cooled & Evaporative Cooling Air Conditioners - All Sizes	HVAC	Water Cooled & Evaporative Cooling Air Conditioners - All Sizes	Electric	Down-stream	0.93	0.93	0.93	Median of 3 values from literature review for programs with non-specific cooling measures	9. Program Level Same Delivery Mode	None
Desuperheater	Waterheating	Water Heating	Electric		0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
Heat Pump Water Heater - C&I	Waterheating	Water Heating	Electric	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
DHW Storage, Gas-Fired, < 75,000 Btuh, (<55gallons), (75 MBH) > 0.67 EF or 0.64 UEF	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
DHW Storage, Gas-Fired, < 75,000 Btuh, (>55gallons) (75 MBH) > 0.81 UEF	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
DHW Storage, Gas-Fired, 75,000 to 105,000 Btuh, > 82% TE (Should be TE Thermal Efficiency)	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
DHW Storage, Gas-Fired, 75,000 to 105,000 Btuh, > 94% TE (Should be TE Thermal Efficiency)	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
DHW Storage, Gas-Fired, > 105,000 Btuh (105 MBH), > 82% TE (Should be TE Thermal Efficiency)	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
DHW Storage, Gas-Fired, > 105,000 Btuh (105 MBH), > 94% TE (Should be TE Thermal Efficiency)	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
DHW, Instant, Gas-Fired, < 200,000 Btuh, > 90% TE (Should be TE Thermal Efficiency)	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None

Measure	End Use	Measure Group	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
DHW, Instant, Gas-Fired, > 200,000 Btuh, > 90% TE (Should be TE Thermal Efficiency)	Waterheating	Water Heating, Natural Gas	Natural Gas	Down-stream	0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None
Gas Cooling Application Regenerative Desiccant Unit GC7	HVAC		Natural Gas		0.80	0.80	0.80	Median of 35 downstream prescriptive program values from literature review	9. Program Level Same Delivery Mode	a. Removed Outliers
Wrapped Lens	Lighting		Electric		0.58	0.53	0.48	Median of 16 linear lamp and fixture values from literature review	7. Partial Measure Group	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
Gas Heating Domestic Hot Water Pipe Wrap Insulation ≤0.5” Diameter GH31 > 0.5” Diameter GH32	Waterheating		Natural Gas		0.71	0.71	0.71	Median of 6 values from literature review	9. Program Level Same Delivery Mode	None

11.2 RESIDENTIAL NTG

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Multifamily - Unless otherwise specified							See Method	See Method	See Method		Apply Residential NTG Ratios to In-Unit Measures and Commercial NTG Ratios to Common Area Measures	
Clothes Washer Tier 1	RA2001	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.51	0.51	0.51	Median of 3 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Clothes Washer Tier 2	RA2002	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.51	0.51	0.51	Median of 3 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Clothes Dryer Tier 1	RA2003	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Clothes Dryer Tier 2	RA2004	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Clothes Dryer Gas - Tier 1	RA2005	Efficient Products	Appliances	Utilities	Natural Gas	Down-stream	0.58	0.58	0.58	Median of 6 values from literature	4. Multiple Directly Comparable Sources	None
Refrigerator Tier 1	RA2006	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.47	0.47	0.47	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Refrigerator Tier 2	RA2007	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.47	0.47	0.47	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Refrigerator Compact (<7.75 CF)	RA2008	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.47	0.47	0.47	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Freezers	RA2009	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.52	0.52	0.52	Median of 26 kitchen and laundry appliance values in literature	7. Partial Measure Group	a. Removed Outliers
Dishwasher	RA2010	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.52	0.52	0.52	Median of 26 kitchen and laundry appliance values in literature	7. Partial Measure Group	a. Removed Outliers
Induction Cooktop Stove	RA2011	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.67	0.67	0.67	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Air Purifier / Cleaner	RA2012	Efficient Products	Appliances	Utilities	Electric	Online	0.65	0.65	0.65	Median of 13 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Air Purifier / Cleaner	RA2012	Efficient Products	Appliances	Utilities	Electric	Upstream	0.65	0.65	0.65	Median of 13 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers
Room A/C Unit	RA2013	Efficient Products	Appliances	Utilities	Electric	Upstream	0.54	0.54	0.54	Median of 9 values from literature	4. Multiple Directly Comparable Sources	None
Dehumidifier	RA2014	Efficient Products	Appliances	Utilities	Electric	Online	0.49	0.49	0.49	Median of 12 values from literature	4. Multiple Directly Comparable Sources	None
Dehumidifier	RA2014	Efficient Products	Appliances	Utilities	Electric	Upstream	0.49	0.49	0.49	Median of 12 values from literature	4. Multiple Directly Comparable Sources	None
Pool Pump - Variable Speed	RA2021	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.86	0.86	0.86	Median of 7 values from literature	4. Multiple Directly Comparable Sources	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Sound Bars	RA2022	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.83	0.83	0.83	Median of 2 values from literature	4. Multiple Directly Comparable Sources	None
Water Cooler	RA2023	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.52	0.52	0.52	Median of 26 kitchen and laundry appliance values in literature	7. Partial Measure Group	a. Removed Outliers
Electric Vehicle Charger - Multifamily	RA2024	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.87	0.84	0.81	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
Electric Vehicle Charger - Single Family	RA2024	Efficient Products	Appliances	Utilities	Electric	Down-stream	0.77	0.74	0.71	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
Clothes Dryer - Multifamily all tiers		Efficient Products	Appliances	Utilities	Electric	Down-stream	0.64	0.64	0.64	Median of 6 values from literature	4. Multiple Directly Comparable Sources	b. 10% Multifamily Boost
Room A/C Unit - Multifamily		Efficient Products	Appliances	Utilities	Electric	All modes	0.59	0.59	0.59	Median of 9 values from literature	4. Multiple Directly Comparable Sources	b. 10% Multifamily Boost
Dishwasher - Multifamily		Efficient Products	Appliances	Utilities	Electric	Down-stream	0.57	0.57	0.57	Median of 26 kitchen and laundry appliance values in literature	7. Partial Measure Group	a. Removed Outliers; b. 10% Multifamily Boost
Clothes Washer - Multifamily all tiers		Efficient Products	Appliances	Utilities	Electric	Down-stream	0.56	0.56	0.56	Median of 3 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers; b. 10% Multifamily Boost
Refrigerator - Multifamily, all tiers		Efficient Products	Appliances	Utilities	Electric	Down-stream	0.52	0.52	0.52	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers; b. 10% Multifamily Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Refrigerator Recycling (between 10-30 cubic feet)	RE6001	Efficient Products	Early Retirement / Recycling	Utilities	Electric	Down-stream	0.51	0.51	0.51	Median of 19 values from literature	5. Similar Measures, Delivery Mode	None
Freezer Recycling (between 10-30 cubic feet)	RE6002	Efficient Products	Early Retirement / Recycling	Utilities	Electric	Down-stream	0.58	0.58	0.58	Median of 14 values from literature	5. Similar Measures, Delivery Mode	None
Room A/C Unit Recycling	RE6003	Efficient Products	Early Retirement / Recycling	Utilities	Electric	Down-stream	0.50	0.50	0.50	Median of 6 values from literature	5. Similar Measures, Delivery Mode	None
Dehumidifier Recycling	RE6004	Efficient Products	Early Retirement / Recycling	Utilities	Electric	Down-stream	0.41	0.41	0.41	Median of 7 values from literature	5. Similar Measures, Delivery Mode	None
Circulating Pump	RF8001	Efficient Products	Fans & Pumps	Utilities	Electric	Hybrid	0.80	0.80	0.80	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Circulating Pump	RF8001	Efficient Products	Fans & Pumps	Utilities	Electric	Down-stream	0.76	0.76	0.76	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	None
Circulating Pump (Gas)	RF8002	Efficient Products	Fans & Pumps	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Circulating Pump (Gas)	RF8002	Efficient Products	Fans & Pumps	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	None
Bathroom Fan	RF8003	Efficient Products	Fans & Pumps	Utilities	Electric	Hybrid	0.63	0.63	0.63	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	d. 5% Hybrid Incentive Boost
Bathroom Fan	RF8003	Efficient Products	Fans & Pumps	Utilities	Electric	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Thermostats - Gas Heat and no CAC or muni	RA2015	Efficient Products	HVAC	Utilities	Natural Gas	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat and no CAC or muni	RA2015	Efficient Products	HVAC	Utilities	Natural Gas	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat and no CAC or muni	RA2015	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RA2016	Efficient Products	HVAC	Utilities	Natural Gas	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RA2016	Efficient Products	HVAC	Utilities	Electric	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RA2016	Efficient Products	HVAC	Utilities	Natural Gas	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RA2016	Efficient Products	HVAC	Utilities	Electric	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RA2016	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RA2016	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RA2017	Efficient Products	HVAC	Utilities	Electric	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RA2017	Efficient Products	HVAC	Utilities	Electric	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Thermostats - Electric A/C and Elec Heat	RA2017	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RA2018	Efficient Products	HVAC	Utilities	Electric	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RA2018	Efficient Products	HVAC	Utilities	Electric	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RA2018	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RA2019	Efficient Products	HVAC	Utilities	Electric	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RA2019	Efficient Products	HVAC	Utilities	Electric	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RA2019	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats	RA2020	Efficient Products	HVAC	Utilities	Natural Gas	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats	RA2020	Efficient Products	HVAC	Utilities	Electric	Online	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats	RA2020	Efficient Products	HVAC	Utilities	Natural Gas	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats	RA2020	Efficient Products	HVAC	Utilities	Electric	Upstream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Thermostats	RA2020	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats	RA2020	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Central Air Conditioning Tier 1 (SEER >=16, EER >=12.5)	RV7001	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.78	0.78	0.78	Median of 7 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Central Air Conditioning Tier 1 (SEER >=16, EER >=12.5)	RV7001	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.74	0.74	Median of 7 values from literature	5. Similar Measures, Delivery Mode	None
Central Air Conditioning Tier 2 (SEER >=18, EER >=13)	RV7002	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.78	0.78	0.78	Median of 7 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Central Air Conditioning Tier 2 (SEER >=18, EER >=13)	RV7002	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.74	0.74	Median of 7 values from literature	5. Similar Measures, Delivery Mode	None
Air Source Heat Pump Tier 1 (SEER >=16, EER>= 12.5, HSPF >=9)	RV7003	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.75	0.72	0.69	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 1 (SEER >=16, EER>= 12.5, HSPF >=9)	RV7003	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.71	0.68	0.65	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Air Source Heat Pump Tier 1 (SEER >=16, EER>= 12.5, HSPF >=9)	RV7003	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.68	0.65	0.62	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 1 (SEER >=16, EER>= 12.5, HSPF >=9)	RV7003	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.65	0.62	0.59	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 2 (SEER >=18, EER >=13, HSPF >=10)	RV7004	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.75	0.72	0.69	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 2 (SEER >=18, EER >=13, HSPF >=10)	RV7004	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.71	0.68	0.65	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 2 (SEER >=18, EER >=13, HSPF >=10)	RV7004	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.68	0.65	0.62	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 2 (SEER >=18, EER >=13, HSPF >=10)	RV7004	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.65	0.62	0.59	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RV7005	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.82	0.79	0.76	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost; e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RV7005	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.78	0.75	0.72	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RV7005	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.75	0.72	0.69	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost; e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RV7005	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.72	0.69	0.66	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air to Water Heat Pump (COP >1.75 at full load capacity and 110 deg F water temp)	RV7006	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.82	0.82	0.82	Median of 2 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Air to Water Heat Pump (COP >1.75 at full load capacity and 110 deg F water temp)	RV7006	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.78	0.78	0.78	Median of 2 values from literature	6. Similar Measures, All Delivery Modes	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Geothermal Heat Pump Energy Star Closed Loop Wtr to Air EER >= 17.1 Closed Loop Wtr to Wtr EER >= 21.1 Open Loop Wtr to Air EER >= 16.1 Open Loop Wtr to Wtr EER >= 20.1	RV7007	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.72	0.72	0.72	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Geothermal Heat Pump Energy Star Closed Loop Wtr to Air EER >= 17.1 Closed Loop Wtr to Wtr EER >= 21.1 Open Loop Wtr to Air EER >= 16.1 Open Loop Wtr to Wtr EER >= 20.1	RV7007	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.67	0.67	0.67	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Ductless Mini-Split Heat Pump Multi (SEER >= 18, EER >=12.5 or HSPF >= 10) Single (SEER >= 20, EER >=12.5 or HSPF >= 10)	RV7008	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.75	0.72	0.69	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless Mini-Split Heat Pump Multi (SEER >= 18, EER >=12.5 or HSPF >= 10) Single (SEER >= 20,	RV7008	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.71	0.68	0.65	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
EER >=12.5 or HSPF >= 10)												
Ductless Mini-Split Heat Pump Multi (SEER >= 18, EER >=12.5 or HSPF >= 10) Single (SEER >= 20, EER >=12.5 or HSPF >= 10)	RV7008	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.68	0.65	0.62	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless Mini-Split Heat Pump Multi (SEER >= 18, EER >=12.5 or HSPF >= 10) Single (SEER >= 20, EER >=12.5 or HSPF >= 10)	RV7008	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.65	0.62	0.59	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless Mini Split A/C (SEER >= 20, EER >=12.5)	RV7009	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.75	0.72	0.69	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless Mini Split A/C (SEER >= 20, EER >=12.5)	RV7009	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.71	0.68	0.65	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless Mini Split A/C (SEER >= 20, EER >=12.5)	RV7009	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.68	0.65	0.62	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Ductless Mini Split A/C (SEER >= 20, EER >=12.5)	RV7009	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.65	0.62	0.59	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Furnace Fans (ECM motor install)	RV7010	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.66	0.66	0.66	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Furnace Fans (ECM motor install)	RV7010	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.63	0.63	0.63	Median of 3 values from literature	5. Similar Measures, Delivery Mode	None
PTAC - CEE Tier 2 - Multi Family	RV7011	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
PTAC - CEE Tier 2 - Multi Family	RV7011	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
PTHP - CEE Tier 2- Multi Family	RV7012	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
PTHP - CEE Tier 2- Multi Family	RV7012	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
Reset controls for boiler	RV7013	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Reset controls for boiler	RV7013	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Gas Boiler (90-95% AFUE)5	RV7014	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Gas Boiler (90-95% AFUE)5	RV7014	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	None
Gas Boiler (>95% AFUE)5	RV7015	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Gas Boiler (>95% AFUE)5	RV7015	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	None
Gas Furnace - Tier 1 (>95%)5	RV7016	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Gas Furnace - Tier 1 (>95%)5	RV7016	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	None
Gas Furnace - Tier 2 (>97%)5	RV7017	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Gas Furnace - Tier 2 (>97%)5	RV7017	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	None
Gas Combi Heat Tier 1(AFUE >95%)	RV7018	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Gas Combi Heat Tier 1(AFUE >95%)	RV7018	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	None
Gas Combi Heat Tier 2(AFUE >97%)	RV7019	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Hybrid Incentive Boost
Gas Combi Heat Tier 2(AFUE >97%)	RV7019	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RV7020	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of 11 values in literature for envelope insulation	8. Full Measure Group	d. 5% Hybrid Incentive Boost
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RV7020	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	none
Qualifying Gas Heat with qualifying Gas Water Heat >55gallons,UEF>.64	RV7021	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.80	0.80	0.80	Median of 11 values in literature for envelope insulation	8. Full Measure Group	d. 5% Hybrid Incentive Boost
Qualifying Gas Heat with qualifying Gas Water Heat >55gallons,UEF>.64	RV7021	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	none
Smart Thermostats - Gas Heat and no CAC or muni	RV7022	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.78	0.75	0.72	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat and no CAC or muni	RV7022	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RV7023	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.78	0.75	0.72	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RV7023	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.78	0.75	0.72	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Thermostats - Gas Heat w/ CAC	RV7023	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RV7023	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RV7024	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.78	0.75	0.72	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RV7024	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RV7025	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.78	0.75	0.72	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RV7025	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RV7026	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.78	0.75	0.72	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	d. 5% Boost for Hybrid Incentive; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RV7026	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
HVAC Maintenance	RV7027	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
HVAC Maintenance	RV7027	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Maintenance	RV7027	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Maintenance	RV7027	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Quality Install	RV7028	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Quality Install	RV7028	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Quality Install	RV7028	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Quality Install	RV7028	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Properly Maintained Boiler (note: discuss timing. Previously assumed these would kick off later)	RV7029	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Properly Maintained Furnace (note: discuss timing. Previously assumed these would kick off later)	RV7030	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Properly Maintained Furnace (note: discuss timing. Previously assumed these would kick off later)	RV7030	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Quality Install	RV7031	Efficient Products	HVAC	Utilities	Natural Gas	Hybrid	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Quality Install	RV7031	Efficient Products	HVAC	Utilities	Electric	Hybrid	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Quality Install	RV7031	Efficient Products	HVAC	Utilities	Natural Gas	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Quality Install	RV7031	Efficient Products	HVAC	Utilities	Electric	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
All ducted and ductless air source heat pumps and HPWH - multifamily		Efficient Products	HVAC	Utilities	Electric	Down-stream	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
All non-heat pump HVAC/WH - multifamily		Efficient Products	HVAC	Utilities	Electric	Down-stream	0.86	0.86	0.86	Median of 9 values from literature	6. Similar Measures, All Delivery Modes	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
EE Kits - Power strip included, no LEDs (other than nightlights)	RS13001	Efficient Products	Kits	Utilities	Electric	Online	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
EE Kits - water conservation measures included, no power strip or LEDs (other than nightlights)	RS13001	Efficient Products	Kits	Utilities	Electric	Online	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
EE Kits - LED light bulbs included (other than nightlights)	RS13001	Efficient Products	Kits	Utilities	Electric	Online	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Lamps164	RL1001	Efficient Products	Lighting	Utilities	Electric	Online	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Lamps165	RL1001	Efficient Products	Lighting	Utilities	Electric	Upstream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Fixtures - retrofit kits and integrated luminaires	RL1002.1	Efficient Products	Lighting	Utilities	Electric	Online	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Fixtures - retrofit kits and integrated luminaires	RL1002.1	Efficient Products	Lighting	Utilities	Electric	Upstream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Fixtures - medium screw base166	RL1002.2	Efficient Products	Lighting	Utilities	Electric	Online	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None

164 NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf
165 NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf
166 NTG Source: https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
LED Fixtures - medium screw base167	RL1002.2	Efficient Products	Lighting	Utilities	Electric	Upstream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Table/Desk Lamps - integrated luminaires (otherwise see MSB)	RL1003	Efficient Products	Lighting	Utilities	Electric	Online	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Table/Desk Lamps - integrated luminaires (otherwise see MSB)	RL1003	Efficient Products	Lighting	Utilities	Electric	Upstream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Holiday Lights	RL1004	Efficient Products	Lighting	Utilities	Electric	Online	0.45	0.40	0.35	Evaluator Assigned based on market data	10. Evaluator Assigned	g. Annual Decrease (5 percentage points) Due to Rapid Commercialization; k. National Shipment Data
LED Holiday Lights	RL1004	Efficient Products	Lighting	Utilities	Electric	Upstream	0.45	0.40	0.35	Evaluator Assigned based on market data	10. Evaluator Assigned	g. Annual Decrease (5 percentage points) Due to Rapid Commercialization; k. National Shipment Data
Ceiling Fans - integrated luminaire (otherwise see MSB)	RL1005	Efficient Products	Lighting	Utilities	Electric	Upstream	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
Occupancy Sensors	RL1006	Efficient Products	Lighting	Utilities	Electric	Online	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Occupancy Sensors	RL1006	Efficient Products	Lighting	Utilities	Electric	Upstream	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Monitors	RO4001	Efficient Products	Office	Utilities	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data

[167] https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Monitors	RO4001	Efficient Products	Office	Utilities	Electric	Upstream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
Computers	RO4002	Efficient Products	Office	Utilities	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
Computers	RO4002	Efficient Products	Office	Utilities	Electric	Upstream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
Imaging	RO4003	Efficient Products	Office	Utilities	Electric	Down-stream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
Imaging	RO4003	Efficient Products	Office	Utilities	Electric	Upstream	0.27	0.24	0.21	Evaluator Assigned based on market data	10. Evaluator Assigned	k. National Shipment Data
TVs	RO4004	Efficient Products	Office	Utilities	Electric	Down-stream	0.83	0.83	0.83	Median of 2 values from literature	5. Similar Measures, Delivery Mode	None
TVs	RO4004	Efficient Products	Office	Utilities	Electric	Upstream	0.83	0.83	0.83	Median of 2 values from literature	5. Similar Measures, Delivery Mode	None
Smart Strip Plug Outlets - Tier 1	RP5001	Efficient Products	Plug Loads	Utilities	Electric	Online	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Smart Strip Plug Outlets - Tier 1	RP5001	Efficient Products	Plug Loads	Utilities	Electric	Upstream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Smart Strip Plug Outlets - Tier 2	RP5002	Efficient Products	Plug Loads	Utilities	Electric	Online	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Smart Strip Plug Outlets - Tier 2	RP5002	Efficient Products	Plug Loads	Utilities	Electric	Upstream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Home	RP5003	Efficient Products	Plug Loads	Utilities	Electric	Online	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
Low flow Showerhead - not TSV	RA2025	Efficient Products	Waterheating	Utilities	Natural Gas	Online	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Low flow Showerhead - not TSV	RA2025	Efficient Products	Waterheating	Utilities	Electric	Online	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Faucet Aerator	RA2026	Efficient Products	Waterheating	Utilities	Natural Gas	Online	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Faucet Aerator	RA2026	Efficient Products	Waterheating	Utilities	Electric	Online	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Pipe Insulation	RA2027	Efficient Products	Waterheating	Utilities	Natural Gas	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Pipe Insulation	RA2027	Efficient Products	Waterheating	Utilities	Electric	Down-stream	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Smart waterheater controller	RNMR-1	Efficient Products	Waterheating	Rockland Electric	Natural Gas	Online	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
Heat Pump waterheater	RW3001	Efficient Products	Waterheating	Utilities	Electric	Down-stream	0.78	0.78	0.78	Median of 2 values from literature	4. Multiple Directly Comparable Sources	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Heat Pump waterheater	RW3001	Efficient Products	Waterheating	Utilities	Electric	Upstream	0.78	0.78	0.78	Median of 2 values from literature	4. Multiple Directly Comparable Sources	None
Gas Storage Tank waterheater - Power Vented <55 gallons, UEF>.64 Medium Draw Pattern UEF ≥ 0.64 High Draw Pattern UEF ≥ 0.68	RW3002	Efficient Products	Waterheating	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None
Gas Storage Tank waterheater - Power Vented <55 gallons, UEF>.64 Medium Draw Pattern UEF ≥ 0.64 High Draw Pattern UEF ≥ 0.68	RW3002	Efficient Products	Waterheating	Utilities	Natural Gas	Upstream	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None
Gas Storage Tank waterheater - Power Vented >55 gallons, UEF>.85 Medium Draw Pattern UEF ≥ 0.78 High Draw Pattern UEF ≥ 0.80	RW3003	Efficient Products	Waterheating	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None
Gas Storage Tank waterheater - Power Vented >55 gallons, UEF>.85 Medium Draw Pattern UEF ≥ 0.78 High Draw Pattern UEF ≥ 0.80	RW3003	Efficient Products	Waterheating	Utilities	Natural Gas	Upstream	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Tankless WH, UEF>=0.87	RW3004	Efficient Products	Waterheating	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None
Tankless WH, UEF>=0.87	RW3004	Efficient Products	Waterheating	Utilities	Natural Gas	Upstream	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None
Indirect - Fired Storage Tank waterheater* (must be attached to Energy Star rated heating Source)	RW3005	Efficient Products	Waterheating	Utilities	Natural Gas	Down-stream	0.76	0.76	0.76	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	none
Indirect - Fired Storage Tank waterheater* (must be attached to Energy Star rated heating Source)	RW3005	Efficient Products	Waterheating	Utilities	Natural Gas	Upstream	0.76	0.76	0.76	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	none
QHEC- PIPE INSULATION	RQ10007	QHEC	Waterheating	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Refrigerator Replacement for MIW	RM11065	Moderate Income Weatherization	Appliances	Utilities	Electric	Direct Install	0.52	0.52	0.52	Median of 6 values from literature	4. Multiple Directly Comparable Sources	a. Removed Outliers; c. 10% Moderate Income Boost
Behavioral Programs - Opt-out Home Energy Report / Randomized Control Design	RNMR-2	Existing Homes	Behavioral	Utilities	Electric	Direct Install	1.00	1.00	1.00	Randomized Control Design	2. Randomized Control Design	None
Behavioral Programs - Virtual Audit	RNMR-2.1	Existing Homes	Behavioral	Utilities	Electric	Direct Install	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Behavioral Programs - Other	RNMR-2.2	Existing Homes	Behavioral	Utilities	Electric	Direct Install	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Behavioral Programs - Opt-out Home Energy Report / Randomized Control Design	RNMR-3	Existing Homes	Behavioral	Utilities	Natural Gas	Direct Install	1.00	1.00	1.00	Randomized Control Design	2. Randomized Control Design	None
Behavioral Programs - Virtual Audit	RNMR-3.1	Existing Homes	Behavioral	Utilities	Natural Gas	Direct Install	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Behavioral Programs - Other	RNMR-3.2	Existing Homes	Behavioral	Utilities	Natural Gas	Direct Install	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Contractor Incentive	RH9001	Home Performance	Contractor Incentive	Utilities	Electric	Midstream	0.00	0.00	0.00	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Contractor Incentive	RH9001	Home Performance	Contractor Incentive	Utilities	Natural Gas	Midstream	0.00	0.00	0.00	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Exhaust Ventilation Fans	RH9010	Home Performance	Fans & Pumps	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Furnace Fans (ECM motor install)	RH9021	Home Performance	Fans & Pumps	Utilities	Electric	Direct Install	0.63	0.63	0.63	Median of 3 values from literature	5. Similar Measures, Delivery Mode	None
Circulating Pump	RH9024	Home Performance	Fans & Pumps	Utilities	Electric	Direct Install	0.76	0.76	0.76	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	None
Exhaust Ventilation Fans	RM11009	Moderate Income Weatherization	Fans & Pumps	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
										values in literature		
Furnace Fans (ECM motor install)	RM11020	Moderate Income Weatherization	Fans & Pumps	Utilities	Electric	Direct Install	0.69	0.69	0.69	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Circulating Pump	RM11023	Moderate Income Weatherization	Fans & Pumps	Utilities	Electric	Direct Install	0.84	0.84	0.84	Median of 3 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Smart Thermostat	RH9008	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat	RH9008	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Heat/Energy Recovery Ventilator	RH9011	Home Performance	HVAC	Utilities	Electric	Direct Install	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Central Air Conditioning Tier 1 (SEER >=16, EER >=12.5)	RH9012	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.74	0.74	Median of 7 values from literature	5. Similar Measures, Delivery Mode	None
Central Air Conditioning Tier 2 (SEER >=18, EER >=13)	RH9013	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.74	0.74	Median of 7 values from literature	5. Similar Measures, Delivery Mode	None
Air Source Heat Pump Tier 1 (SEER >=16, EER>= 12.5 HSPF >=9)	RH9014	Home Performance	HVAC	Utilities	Electric	Direct Install	0.65	0.62	0.59	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 2	RH9015	Home Performance	HVAC	Utilities	Electric	Direct Install	0.71	0.68	0.65	Median of 15 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
(SEER >=18, EER >=13, HSPF >=10)										(including single value reserved for fuel switching)		
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RH9016	Home Performance	HVAC	Utilities	Electric	Direct Install	0.78	0.75	0.72	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RH9016	Home Performance	HVAC	Utilities	Electric	Direct Install	0.72	0.69	0.66	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air to Water Heat Pump (COP >1.75 at full load capacity and 110 deg F water temp)	RH9017	Home Performance	HVAC	Utilities	Electric	Direct Install	0.78	0.78	0.78	Median of 2 values from literature	6. Similar Measures, All Delivery Modes	None
Geothermal Heat Pump Energy Star Closed Loop Wtr to Air EER >= 17.1 Closed Loop Wtr to Wtr EER >= 21.1 Open Loop Wtr to Air EER >= 16.1 Open Loop Wtr to Wtr EER >= 20.1	RH9018	Home Performance	HVAC	Utilities	Electric	Direct Install	0.67	0.67	0.67	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Ductless Mini-Split Heat Pump Multi (SEER >= 18, EER >=12.5 or HSPF >= 10)	RH9019	Home Performance	HVAC	Utilities	Electric	Direct Install	0.71	0.68	0.65	Median of 15 values from literature (including single	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Single (SEER >= 20, EER >=12.5 or HSPF >= 10)										value reserved for fuel switching)		
Ductless Mini Split A/C (SEER >= 20, EER >=12)	RH9020	Home Performance	HVAC	Utilities	Electric	Direct Install	0.65	0.62	0.59	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
PTAC - CEE Tier 2 - Multi Family	RH9022	Home Performance	HVAC	Utilities	Electric	Direct Install	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
PTHP - CEE Tier 2- Multi Family	RH9023	Home Performance	HVAC	Utilities	Electric	Direct Install	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
Reset controls for boiler	RH9025	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Gas Boiler (90-95% AFUE)5	RH9026	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Gas Boiler (>95% AFUE)5	RH9027	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Gas Furnace - Tier 1 (>95%)5	RH9028	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Gas Furnace - Tier 2 (>97%)5	RH9029	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Gas Combi Heat Tier 1(AFUE >95%)	RH9030	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Gas Combi Heat Tier 2(AFUE >97%)	RH9031	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Quality Install	RH9034	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Quality Install	RH9034	Home Performance	HVAC	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Properly Maintained Boiler (note: discuss timing. Previously assumed these would kick off later)	RH9039	Home Performance	HVAC	Utilities	Natural Gas	?	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Properly Maintained Furnace (note: discuss timing. Previously assumed these would kick off later)	RH9040	Home Performance	HVAC	Utilities	Natural Gas	?	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Properly Maintained Furnace (note: discuss timing. Previously assumed these would kick off later)	RH9040	Home Performance	HVAC	Utilities	Electric	?	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
HVAC Tune-up for AC	RH9041	Home Performance	HVAC	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Smart Thermostats - Gas Heat and no CAC or muni	RH9042	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Thermostats - Gas Heat w/ CAC	RH9043	Home Performance	HVAC	Utilities	Natural Gas	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RH9043	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RH9044	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RH9045	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RH9046	Home Performance	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat	RM11007	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat	RM11007	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Heat/Energy Recovery Ventilator	RM11010	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.85	0.85	0.85	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Central Air Conditioning Tier 1 (SEER >=16, EER >=12.5)	RM11011	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.81	0.81	0.81	Median of 7 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Central Air Conditioning Tier 2	RM11012	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.81	0.81	0.81	Median of 7 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
(SEER >=18, EER >=13)												
Air Source Heat Pump Tier 1 (SEER >=16, EER>= 12.5, HSPF >=9)	RM11013	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.72	0.69	0.66	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump Tier 2 (SEER >=18, EER >=13, HSPF >=10)	RM11014	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.78	0.75	0.72	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RM11015	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.86	0.83	0.80	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air Source Heat Pump - Cold Climate (SEER >=18 , EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RM11015	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.79	0.76	0.73	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; e. 10% Cold Climate Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Air to Water Heat Pump (COP >1.75 at full load capacity and 110 deg F water temp)	RM11016	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.86	0.86	0.86	Median of 2 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Geothermal Heat Pump Energy Star Closed Loop Wtr to Air EER >= 17.1	RM11017	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.77	0.77	0.77	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Closed Loop Wtr to Wtr EER >= 21.1 Open Loop Wtr to Air EER >= 16.1 Open Loop Wtr to Wtr EER >= 20.1												
Ductless Mini-Split Heat Pump Multi (SEER >= 18, EER >=12.5 or HSPF >= 10) Single (SEER >= 20, EER >=12.5 or HSPF >= 10)	RM11018	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.78	0.75	0.72	Median of 15 values from literature (including single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Ductless Mini Split A/C (SEER >= 20, EER >=12)	RM11019	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.72	0.69	0.66	Median of 14 values from literature (excluding single value reserved for fuel switching)	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
PTAC - CEE Tier 2 - Multi Family	RM11021	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
PTHP - CEE Tier 2- Multi Family	RM11022	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
Reset controls for boiler	RM11024	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.85	0.85	0.85	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Gas Boiler (90-95% AFUE)5	RM11025	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Gas Boiler (>95% AFUE)5	RM11026	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Gas Furnace - Tier 1 (>95%)5	RM11027	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Gas Furnace - Tier 2 (>97%)5	RM11028	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Gas Combi Heat Tier 1(AFUE >95%)	RM11029	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Gas Combi Heat Tier 2(AFUE >97%)	RM11030	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Quality Install	RM11033	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Quality Install	RM11033	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Properly Maintained Boiler (note: discuss timing. Previously assumed these would kick off later)	RM11038	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	?	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Properly Maintained Furnace (note: discuss timing. Previously assumed these would kick off later)	RM11039	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	?	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Properly Maintained Furnace (note: discuss timing.	RM11039	Moderate Income Weatherization	HVAC	Utilities	Electric	?	0.66	0.66	0.66	Median of 10 program-level	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Previously assumed these would kick off later)										values in literature		
HVAC Tune-up for AC	RM11040	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Smart Thermostats - Gas Heat and no CAC or muni	RM11048	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RM11049	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RM11049	Moderate Income Weatherization	HVAC	Utilities	Natural Gas	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RM11050	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RM11051	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RM11052	Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.82	0.79	0.76	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost; f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat and no CAC or muni	RQ10008	QHEC	HVAC	Utilities	Natural Gas	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Smart Thermostats - Gas Heat w/ CAC	RQ10009	QHEC	HVAC	Utilities	Natural Gas	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Gas Heat w/ CAC	RQ10009	QHEC	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - Electric A/C and Elec Heat	RQ10010	QHEC	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostat - Electric A/C and No Natural Gas	RQ10011	QHEC	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
Smart Thermostats - No Central A/C and Elec Heat	RQ10012	QHEC	HVAC	Utilities	Electric	Direct Install	0.74	0.71	0.68	Median of 8 values from literature	6. Similar Measures, All Delivery Modes	f. Annual Decrease (3 percentage points) Due to Moderate Commercialization
All non-heat pump HVAC/WH - Multifamily		Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.95	0.95	0.95	Median of 9 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
All ducted and ductless air source heat pumps and HPWH - Multifamily		Home Performance	HVAC	Utilities	Electric	Direct Install	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
All ducted and ductless air source heat pumps and HPWH - Multifamily		Moderate Income Weatherization	HVAC	Utilities	Electric	Direct Install	0.93	0.93	0.93	Median of 2 MF values from literature	6. Similar Measures, All Delivery Modes	None
All non-heat pump HVAC/WH - Multifamily		Home Performance	HVAC	Utilities	Electric	Direct Install	0.86	0.86	0.86	Median of 9 values from literature	6. Similar Measures, All Delivery Modes	none
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RH9032	Home Performance	HVAC / Waterheating	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RH9033	Home Performance	HVAC / Waterheating	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RM11031	Moderate Income Weatherization	HVAC / Waterheating	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	c. 10% Moderate Income Boost
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RM11032	Moderate Income Weatherization	HVAC / Waterheating	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	c. 10% Moderate Income Boost
Attic/Roof/Ceiling Insulation	RH9002	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Attic/Roof/Ceiling Insulation	RH9002	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Wall Insulation	RH9003	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Wall Insulation	RH9003	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Floor Insulation	RH9004	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Floor Insulation	RH9004	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Air Sealing	RH9005	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Air Sealing	RH9005	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Duct Sealing	RH9006	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Duct Sealing	RH9006	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Ductwork / Duct Insulation	RH9007	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Ductwork / Duct Insulation	RH9007	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Attic Floor Insulation	RH9009	Home Performance	Insulation & Envelope	Utilities	Electric	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Attic Floor Insulation	RH9009	Home Performance	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.87	0.87	0.87	Median of 11 values in literature for envelope insulation	8. Full Measure Group	none
Weatherstripping 17-Foot Roll Foam	RI12001	Existing Homes	Insulation & Envelope	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Weatherstripping 17-Foot Roll Foam	RI12001	Existing Homes	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
gaskets-10 pack	RI12002	Existing Homes	Insulation & Envelope	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
gaskets-10 pack	RI12002	Existing Homes	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Attic/Roof/Ceiling Insulation	RM11001	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Attic/Roof/Ceiling Insulation	RM11001	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for	8. Full Measure Group	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
										envelope insulation		
Wall Insulation	RM11002	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Wall Insulation	RM11002	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Floor Insulation	RM11003	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Floor Insulation	RM11003	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Air Sealing	RM11004	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Air Sealing	RM11004	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Duct Sealing	RM11005	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Duct Sealing	RM11005	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Ductwork / Duct Insulation	RM11006	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Ductwork / Duct Insulation	RM11006	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Attic Floor Insulation	RM11008	Moderate Income Weatherization	Insulation & Envelope	Utilities	Electric	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Attic Floor Insulation	RM11008	Moderate Income Weatherization	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.96	0.96	0.96	Median of 11 values in literature for envelope insulation	8. Full Measure Group	c. 10% Moderate Income Boost
Furnace/Air Handler Filter Whistle	RS13002	Existing Homes	Insulation & Envelope	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Furnace/Air Handler Filter Whistle	RS13002	Existing Homes	Insulation & Envelope	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
LED Nightlight	RL1008	Existing Homes	Lighting	Utilities	Electric	Direct Install	0.45	0.40	0.35	Evaluator Assigned based on market data	10. Evaluator Assigned	g. Annual Decrease (5 percentage points) Due to Rapid Commercialization; k. National Shipment Data

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
LED Specialty	RM11041	Moderate Income Weatherization	Lighting	Utilities	Electric	Direct Install	0.17	0.08	0.04	Evaluator Assigned based on market data	10. Evaluator Assigned	c. 10% Moderate Income Boost; i. 50% Annual Decrease Due to AML and State and Federal Standards; j. NJ Market Research
LED Standard	RM11042	Moderate Income Weatherization	Lighting	Utilities	Electric	Direct Install	0.17	0.08	0.04	Evaluator Assigned based on market data	10. Evaluator Assigned	c. 10% Moderate Income Boost; i. 50% Annual Decrease Due to AML and State and Federal Standards; j. NJ Market Research
QHEC - LED Specialty	RQ10001	QHEC	Lighting	Utilities	Electric	Direct Install	0.15	0.08	0.04	Evaluator Assigned based on market data	10. Evaluator Assigned	i. 50% Annual Decrease Due to AML and State and Federal Standards; j. NJ Market Research
QHEC - LED Standard	RQ10002	QHEC	Lighting	Utilities	Electric	Direct Install	0.15	0.08	0.04	Evaluator Assigned based on market data	10. Evaluator Assigned	i. 50% Annual Decrease Due to AML and State and Federal Standards; j. NJ Market Research
SMART STRIP	RM11046	Moderate Income Weatherization	Plug Loads	Utilities	Electric	Direct Install	1.00	1.00	1.00	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
QHEC- SMART STRIP	RQ10006	QHEC	Plug Loads	Utilities	Electric	Direct Install	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Gas Storage Tank waterheater - Power Vented <55 gallons, UEF>.64	RH9035	Home Performance	Waterheating	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None
Gas Storage Tank waterheater - Power Vented >55 gallons, UEF>.85	RH9036	Home Performance	Waterheating	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of 6 value from literature	6. Similar Measures, All Delivery Modes	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Tankless WH, UEF>=0.87	RH9037	Home Performance	Waterheating	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Indirect - Fired Storage Tank waterheater*	RH9038	Home Performance	Waterheating	Utilities	Natural Gas	Direct Install	0.76	0.76	0.76	Median of all 11 values from literature	6. Similar Measures, All Delivery Modes	none
Heat Pump waterheater	RH9047	Home Performance	Waterheating	Utilities	Electric	Direct Install	0.78	0.78	0.78	Median of 2 value from literature	5. Similar Measures, Delivery Mode	None
Gas Storage Tank waterheater - Power Vented <55 gallons, UEF>.64	RM11034	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of 6 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Gas Storage Tank waterheater - Power Vented >55 gallons, UEF>.85	RM11035	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of 6 values from literature	6. Similar Measures, All Delivery Modes	c. 10% Moderate Income Boost
Tankless WH, UEF>=0.87	RM11036	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	c. 10% Moderate Income Boost
Indirect - Fired Storage Tank waterheater*	RM11037	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.84	0.84	0.84	Median of 11 gas heat and 6 gas waterheater values in literature	8. Full Measure Group	c. 10% Moderate Income Boost
Faucet Aerator	RM11043	Moderate Income Weatherization	Waterheating	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Faucet Aerator	RM11043	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
										values in literature		
Efficient Flow Showerhead - not TSV	RM11044	Moderate Income Weatherization	Waterheating	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Efficient Flow Showerhead - not TSV	RM11044	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Kitchen Faucet Aerator	RM11045	Moderate Income Weatherization	Waterheating	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Kitchen Faucet Aerator	RM11045	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
PIPE INSULATION	RM11047	Moderate Income Weatherization	Waterheating	Utilities	Electric	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
PIPE INSULATION	RM11047	Moderate Income Weatherization	Waterheating	Utilities	Natural Gas	Direct Install	0.66	0.66	0.66	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	c. 10% Moderate Income Boost
Thermostatic Restrictor Shower Valve	RM11055	Existing Homes	Waterheating	Utilities	Electric	Direct Install	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
Thermostatic Restrictor Shower Valve	RM11055	Existing Homes	Waterheating	Utilities	Natural Gas	Direct Install	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Heat Pump waterheater	RM11060	Moderate Income Weatherization	Waterheating	Utilities	Electric	Direct Install	0.86	0.86	0.86	Median of 2 values from literature	5. Similar Measures, Delivery Mode	c. 10% Moderate Income Boost
ShowerStart showerhead adapter	RNMR-4	QHEC	Waterheating	Joint	Natural Gas	Direct Install	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
ShowerStart showerhead adapter - Multifamily	RNMR-5	QHEC	Waterheating	Joint	Electric	Direct Install	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	l. Broad Market Trends
QHEC- Faucet Aerator	RQ10003	QHEC	Waterheating	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
QHEC- Faucet Aerator	RQ10003	QHEC	Waterheating	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
QHEC- Efficient Flow Showerhead - not TSV	RQ10004	QHEC	Waterheating	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
QHEC- Efficient Flow Showerhead - not TSV	RQ10004	QHEC	Waterheating	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
QHEC- Kitchen Faucet Aerator	RQ10005	QHEC	Waterheating	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
QHEC- Kitchen Faucet Aerator	RQ10005	QHEC	Waterheating	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
QHEC- PIPE INSULATION	RQ10007	QHEC	Waterheating	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Waterheater setback	RW3006	Existing Homes	Waterheating	Utilities	Electric	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Waterheater setback	RW3006	Existing Homes	Waterheating	Utilities	Natural Gas	Direct Install	0.60	0.60	0.60	Median of 10 program-level values in literature	9. Program Level, Same Delivery Mode	none
Replacement of inefficient refrigerators	RNMR-6	Comfort Partners	Appliances	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Comprehensive, personalized energy education and counseling	RNMR-36	Comfort Partners	Behavioral	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Comprehensive, personalized energy education and counseling	RNMR-37	Comfort Partners	Behavioral	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Thermostats	RNMR-10	Comfort Partners	HVAC	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Heating/cooling equipment maintenance; and other measures	RNMR-7	Comfort Partners	HVAC	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Heating/cooling equipment maintenance; and other measures	RNMR-8	Comfort Partners	HVAC	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Thermostats	RNMR-9	Comfort Partners	HVAC	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Air Sealing	RNMR-11	Comfort Partners	Insulation & Envelope	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Air Sealing	RNMR-12	Comfort Partners	Insulation & Envelope	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Duct sealing and repair	RNMR-13	Comfort Partners	Insulation & Envelope	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Duct sealing and repair	RNMR-14	Comfort Partners	Insulation & Envelope	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
EEP Door Sealing	RNMR-15	Comfort Partners	Insulation & Envelope	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
EEP Door Sealing	RNMR-16	Comfort Partners	Insulation & Envelope	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
EEP Door Sweeps	RNMR-17	Comfort Partners	Insulation & Envelope	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
EEP Door Sweeps	RNMR-18	Comfort Partners	Insulation & Envelope	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
EEP Foam Sealant	RNMR-19	Comfort Partners	Insulation & Envelope	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
EEP Foam Sealant	RNMR-20	Comfort Partners	Insulation & Envelope	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Insulation (attic, wall, etc.)	RNMR-21	Comfort Partners	Insulation & Envelope	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Insulation (attic, wall, etc.)	RNMR-22	Comfort Partners	Insulation & Envelope	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Efficient Fixtures - retrofit kits and integrated luminaires (otherwise use screw-in lamp)	RNMR-23	Comfort Partners	Lighting	Joint	Electric	Direct Install	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Horticultural LEDs	RNMR-24	Comfort Partners	Lighting	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Ceiling Fans - integrated luminaire (otherwise use screw-in lamp)	RNMR-25	Comfort Partners	Lighting	Joint	Electric	Direct Install	0.00	0.00	0.00	Federal or state standard	3. Federal or State Standard	None
LED Screw In Lamp	RNMR-26	Comfort Partners	Lighting	Joint	Electric	Direct Install	0.18	0.09	0.05	Evaluator Assigned based on market data	10. Evaluator Assigned	h. 10% Low Income Boost (over moderate); i. 50% Annual Decrease Due to AML and State and Federal Standards; j. NJ Market Research
ShowerStart showerhead adapter - assume TSV	RNMR-27	Comfort Partners	Waterheating	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
ShowerStart showerhead adapter - assume TSV	RNMR-28	Comfort Partners	Waterheating	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Low flow faucet aerators (Electric)	RNMR-29	Comfort Partners	Waterheating	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Low flow Showerhead - not TSV	RNMR-30	Comfort Partners	Waterheating	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
Low flow Showerhead - not TSV	RNMR-31	Comfort Partners	Waterheating	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
waterheater insulation	RNMR-32	Comfort Partners	Waterheating	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
waterheater insulation	RNMR-33	Comfort Partners	Waterheating	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. 25	None
Water pipe insulation	RNMR-34	Comfort Partners	Waterheating	Joint	Electric	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None

Measure	Unique ID #	Program	Measure Group	PA	Fuel Type	Delivery Mode	NTG 2024	NTG 2025	NTG 2026	NTG Basis	Method	Variation
Water pipe insulation	RNMR-35	Comfort Partners	Waterheating	Joint	Natural Gas	Direct Install	1.00	1.00	1.00	Low Income	1. Low Income	None
ZERH + RE Multifamily		RNC	Whole Program	NJCEP	Both	Midstream	0.90	0.90	0.90	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
ZERH Multifamily		RNC	Whole Program	NJCEP	Both	Midstream	0.85	0.85	0.85	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
ZERH + RE Single-family + Townhouse		RNC	Whole Program	NJCEP	Both	Midstream	0.85	0.85	0.85	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
ENERGY STAR Multifamily		RNC	Whole Program	NJCEP	Both	Midstream	0.80	0.80	0.80	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
ZERH Single-family + Townhouse		RNC	Whole Program	NJCEP	Both	Midstream	0.80	0.80	0.80	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
ENERGY STAR Single-family + Townhouse		RNC	Whole Program	NJCEP	Both	Midstream	0.75	0.75	0.75	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends
UEZ / Affordable house Bonus - Single-family + Townhouse		RNC	Whole Program	NJCEP	Both	Midstream	0.00	Add 5% to NTG to each tier above	Add 5% to NTG to each tier above	Evaluator Assigned based on market data	10. Evaluator Assigned	I. Broad Market Trends

12 APPENDIX I: REALIZATION RATES

Prospective realization rates to be applied to gross savings estimates are based on PY1 Evaluation Study findings. Realization rates where sample sizes are < 30 or savings discrepancies are addressed by the 2023 TRM were removed. Changes to program tracking systems or calculation procedures verified by program evaluators were also considered. Measures not listed below do not require a prospective realization rate adjustment.

IOU	Program	Sub Program	Measure	GRR net of ISR		
				kWh	kW	Therm
ACE	Efficient Products	Appliance Rebate	Clothes Dryers	101%	101%	
ACE	Efficient Products	Appliance Rebate	Dehumidifiers	113%	113%	
ACE	Efficient Products	Appliance Rebate	Heat Pump Water Heaters	100%	100%	
ACE	Efficient Products	Appliance Rebate	Refrigerators	101%	101%	
ACE	Efficient Products	Appliance Rebate	Room Air Conditioners	125%	128%	
ACE	Efficient Products	Appliance Recycling	Dehumidifiers	100%	100%	
ACE	Efficient Products	Appliance Recycling	Freezers	101%	101%	
ACE	Efficient Products	Appliance Recycling	Refrigerators	100%	100%	
ACE	Efficient Products	Appliance Recycling	Room Air Conditioners	100%	100%	
ACE	Efficient Products	HVAC	Smart Thermostats	100%		
ACE	Efficient Products	Online Marketplace	Power Strips	100%	102%	
ACE	Efficient Products	Online Marketplace	Smart Thermostats	100%	101%	
ETG	Efficient Products	Marketplace Efficiency Products	Smart Thermostat	100%		100%
JCPL	Efficient Products	Appliance Rebates	Air Purifier – ENERGY STAR	100%	100%	
JCPL	Efficient Products	Appliance Rebates	Clothes Dryer – ENERGY STAR	99%	99%	

IOU	Program	Sub Program	Measure	GRR net of ISR		
				kWh	kW	Therm
JCPL	Efficient Products	Appliance Rebates	Clothes Dryer – ENERGY STAR MOST EFFICIENT	99%	99%	
JCPL	Efficient Products	Appliance Rebates	Refrigerator – ENERGY STAR	100%	100%	
JCPL	Efficient Products	Appliance Rebates	Refrigerator – ENERGY STAR MOST EFFICIENT	100%	100%	
JCPL	Efficient Products	Appliance Recycling	Dehumidifier Recycling	100%	100%	
JCPL	Efficient Products	Appliance Recycling	Freezer Recycling	100%	100%	
JCPL	Efficient Products	Appliance Recycling	Refrigerator Recycling	100%	100%	
JCPL	Efficient Products	HVAC	Smart Thermostat – Electric A/C and Elec Heat	100%		
JCPL	Efficient Products	HVAC	Smart Thermostat – Electric A/C and No Natural Gas	100%		
JCPL	Efficient Products	HVAC	Smart Thermostat – Gas Heat w/ CAC	100%		100%
JCPL	Efficient Products	Online Marketplace	Air purifier	100%	100%	
JCPL	Efficient Products	Online Marketplace	Smart Thermostat	99%		99%
JCPL	Existing Homes	Moderate Income Weatherization	Advanced Power Strips	100%	100%	
JCPL	Existing Homes	Moderate Income Weatherization	Domestic Hot Water Setback	100%	100%	
JCPL	Existing Homes	Moderate Income Weatherization	Faucet Aerators	100%	-	
JCPL	Existing Homes	Moderate Income Weatherization	LED Lightbulbs	100%	100%	
JCPL	Existing Homes	Moderate Income Weatherization	Low Flow Showerheads	100%	-	
JCPL	Existing Homes	QHEC	Domestic Hot Water Setback	108%	108%	
JCPL	Multifamily	Direct Install	LED Nightlight - Tenant	100%	-	
NJNG	Existing Homes	QHEC	LED Nightlight	100%	100%	

IOU	Program	Sub Program	Measure	GRR net of ISR		
				kWh	kW	Therm
NJNG	Existing Homes	QHEC	LED Screw-in General Service Lamp	100%	100%	
PSEG	Efficient Products	Appliance Recycling	Dehumidifier	100%	100%	
PSEG	Efficient Products	Appliance Recycling	Freezer	100%	100%	
PSEG	Efficient Products	Appliance Recycling	Refrigerator	100%	100%	
PSEG	Efficient Products	Downstream Rebates	Clothes Washer	100%	100%	100%
PSEG	Efficient Products	Downstream Rebates	Electric Clothes Dryers	100%	100%	
PSEG	Efficient Products	Downstream Rebates	Gas Clothes Dryers	100%	100%	100%
PSEG	Efficient Products	Downstream Rebates	Heat Pump Water Heater	100%	100%	
PSEG	Efficient Products	Downstream Rebates	Refrigerators	99%	99%	
PSEG	Efficient Products	Downstream Rebates	Smart Thermostat	100%		100%
PSEG	Efficient Products	Downstream Rebates	Storage Water heater			101%
PSEG	Efficient Products	Midstream HVAC	Air Source Heat Pump	100%	100%	
PSEG	Efficient Products	Midstream HVAC	Central Air Conditioner	98%	98%	
PSEG	Efficient Products	Midstream HVAC	Gas Boiler			102%
PSEG	Efficient Products	Midstream HVAC	Gas Furnace			100%
PSEG	Efficient Products	Midstream HVAC	Heat Pump Water Heater	100%	100%	
PSEG	Efficient Products	Midstream HVAC	Qualifying Gas Furnace with qualifying Gas Water Heat			100%
PSEG	Efficient Products	Midstream HVAC	Qualifying Gas Heat with qualifying Gas Water Heat			99%

IOU	Program	Sub Program	Measure	GRR net of ISR		
				kWh	kW	Therm
PSEG	Efficient Products	Midstream HVAC	Smart Thermostat	100%		100%
PSEG	Efficient Products	Midstream HVAC	Water Heater			92%
PSEG	Efficient Products	Midstream Lighting	LED Specialty - ESTAR V2.0	102%	102%	
PSEG	Efficient Products	Midstream Lighting	LED Standard - ESTAR V2.0	100%	100%	
PSEG	Efficient Products	Midstream Markdown	Air Purifier	100%	100%	
PSEG	Efficient Products	Midstream Markdown	Dehumidifier	100%	100%	
PSEG	Efficient Products	Midstream Markdown	RAC	100%	100%	
PSEG	Efficient Products	Online Marketplace	Advanced Power Strip	100%	100%	
PSEG	Efficient Products	Online Marketplace	Aerator	100%		100%
PSEG	Efficient Products	Online Marketplace	Air Quality - Air Purifier	100%	100%	
PSEG	Efficient Products	Online Marketplace	Air Quality - Dehumidifier	100%	100%	
PSEG	Efficient Products	Online Marketplace	Lighting	100%	100%	100%
PSEG	Efficient Products	Online Marketplace	Showerhead	100%		100%
PSEG	Efficient Products	Sightlines	Heat Pump Water Heater	100%	100%	
PSEG	Efficient Products	Welcome Kits	Welcome Kits - Gas			62%
PSEG	Existing Homes	QHEC	Low Flow Showerhead	100%		100%
PSEG	Existing Homes	QHEC	ShowerStart	100%	100%	100%
PSEG	Existing Homes	QHEC	Smart Strip	100%	100%	

IOU	Program	Sub Program	Measure	GRR net of ISR		
				kWh	kW	Therm
PSEG	Income Eligible	IE Weatherization	ShowerStart	89%	89%	84%
PSEG	Income Eligible	IE Weatherization	Smart Strip	98%	98%	
PSEG	Income Eligible	IE Weatherization	Water Heater Setback	95%	95%	99%
PSEG	Multifamily	Direct Install	Lighting	105%	105%	
PSEG	Multifamily	Direct Install	ShowerStart Showerhead Adapter	100%	100%	61%
SJG	Efficient Products	Appliance Rebates	Clothes Dryer			100%
SJG	Efficient Products	HVAC	Central Air Conditioner (Tier 1)	85%	85%	
SJG	Efficient Products	HVAC	Tankless Water Heater			103%
SJG	Efficient Products	Marketplace Efficiency Products	Smart Thermostat	100%		100%
SJG	Existing Homes	QHEC	Advanced Power Strips	100%	100%	

13 APPENDIX J: IN-SERVICE RATES

The table below presents ISR values differentiated by measure, program, and IOU. If no data is provided, use default value provided in measure.

IOU	Program	Sub Program	Measure	ISR
ACE	EE Products	Appliance Rebates	Air Purifiers	0.99
ACE	EE Products	Appliance Rebates	Clothes Dryer	0.98
ACE	EE Products	Appliance Rebates	Clothes Washers	0.98
ACE	EE Products	Appliance Rebates	Dehumidifiers	0.98
ACE	EE Products	Appliance Rebates	Heat Pump Water Heaters	1.00
ACE	EE Products	Appliance Rebates	Refrigerators	0.99
ACE	EE Products	Appliance Rebates	Room Air Conditioners	1.00
ACE	EE Products	Online Marketplace	Advanced Power Strip	0.98
ACE	EE Products	Online Marketplace	Air Purifiers	1.00
ACE	EE Products	Online Marketplace	Lighting	1.03
ACE	EE Products	Online Marketplace	Smart Thermostat	0.99
ETG	EE Products	Online Marketplace	Bathroom Aerator	1.00
ETG	EE Products	Online Marketplace	Kit Kitchen Aerator	0.92
ETG	EE Products	Online Marketplace	Kit Low-Flow Showerhead	0.91
ETG	EE Products	Online Marketplace	Kitchen Aerator	0.92
ETG	EE Products	Online Marketplace	Low-Flow Showerhead	0.91
ETG	EE Products	Online Marketplace	Smart Thermostat	0.96
ETG	Existing Homes	QHEC	LED Bulb	0.98
ETG	Existing Homes	QHEC	Pipe Insulation	0.92
JCPL	C&I	C&I	Lighting	0.96
JCPL	EE Products	Appliance Rebates	Air Purifier	1.00
JCPL	EE Products	Appliance Rebates	Clothes Dryer	1.00
JCPL	EE Products	Appliance Rebates	Dehumidifier	1.00
JCPL	EE Products	Appliance Rebates	Refrigerator	1.00
JCPL	EE Products	Kits	Advanced Power Strip	0.69
JCPL	EE Products	Kits	Faucet Aerator	0.23
JCPL	EE Products	Kits	Furnace Whistle	0.04
JCPL	EE Products	Kits	LED Bulb	0.85

IOU	Program	Sub Program	Measure	ISR
JCPL	EE Products	Kits	LED Nightlight	0.62
JCPL	EE Products	Kits	Low-Flow Showerhead	0.19
JCPL	EE Products	Lighting	All except foodbank kit	0.95
JCPL	EE Products	Online Marketplace	LED Bulb	0.81
JCPL	EE Products	Res HVAC Rebates	CAC	1.00
JCPL	EE Products	Res HVAC Rebates	GSHP	1.00
JCPL	EE Products	Res HVAC Rebates	Minisplit	1.00
JCPL	EE Products	Res HVAC Rebates	Smart Thermostat	1.00
JCPL	SBDI	SBDI	Lighting	0.99
NJNG	Existing Homes	HPwES	Air Sealing & Insulation	0.99
NJNG	Existing Homes	HPwES	Duct Sealing	0.53
NJNG	Existing Homes	HPwES	Heating System	1.00
PSEG	EE Products	Downstream Rebates	Clothes Dryer	0.99
PSEG	EE Products	Downstream Rebates	Clothes Washer	1.00
PSEG	EE Products	Downstream Rebates	Refrigerator	0.98
PSEG	EE Products	Downstream Rebates	Smart thermostat	1.00
PSEG	EE Products	Downstream Rebates	Water heater	1.00
PSEG	EE Products	Midstream HVAC	HVAC	1.00
PSEG	EE Products	Midstream Lighting	Lighting	0.92
PSEG	EE Products	Online Marketplace	Advanced power strip	0.82
PSEG	EE Products	Online Marketplace	Air Purifier	1.00
PSEG	EE Products	Online Marketplace	Dehumidifier	1.00
PSEG	EE Products	Online Marketplace	Energy saving kit	0.88
PSEG	EE Products	Online Marketplace	Faucet Aerator	0.89
PSEG	EE Products	Online Marketplace	LED bulb	0.86
PSEG	EE Products	Online Marketplace	Low-Flow Showerhead	0.93
PSEG	EE Products	Online Marketplace	Smart thermostat	0.78
PSEG	EE Products	Online Marketplace	Water conservation kit	0.60
PSEG	EE Products	Welcome kits	Advanced Power Strip	0.85
PSEG	EE Products	Welcome kits	ENERGY STAR certified desk lamp	0.79
PSEG	EE Products	Welcome kits	LED Bulb	0.75

IOU	Program	Sub Program	Measure	ISR
PSEG	EE Products	Welcome kits	LED Nightlight	0.78
PSEG	EE Products	Welcome kits - gas	Bathroom Aerator	0.40
PSEG	EE Products	Welcome kits - gas	Kitchen Aerator	0.36
PSEG	EE Products	Welcome kits - gas	Low-Flow Showerhead	0.38
PSEG	Existing Homes	Multifamily	Lighting	0.98
PSEG	Existing Homes	QHEC	Advanced Power Strip	0.92
PSEG	Existing Homes	QHEC	Faucet Aerator	0.94
PSEG	Existing Homes	QHEC	LED Bulb	0.96
PSEG	Existing Homes	QHEC	LED Reflector	0.96
PSEG	Existing Homes	QHEC	LED Specialty	0.96
PSEG	Existing Homes	QHEC	Low-Flow Showerhead	0.94
PSEG	Existing Homes	QHEC	Pipe Insulation	1.00
PSEG	Existing Homes	QHEC	ShowerStart	0.94
PSEG	Existing Homes	QHEC	Smart Thermostat	1.00
PSEG	Existing Homes	Residential Income-Eligible	Advanced Power Strip	0.92
PSEG	Existing Homes	Residential Income-Eligible	Faucet Aerator	0.94
PSEG	Existing Homes	Residential Income-Eligible	Food bank LED	0.83
PSEG	Existing Homes	Residential Income-Eligible	Food Bank LED nightlight	0.20
PSEG	Existing Homes	Residential Income-Eligible	LED bulb	0.96
PSEG	Existing Homes	Residential Income-Eligible	LED Reflector	0.96
PSEG	Existing Homes	Residential Income-Eligible	LED Specialty	0.96
PSEG	Existing Homes	Residential Income-Eligible	Low-Flow Showerhead	0.94
PSEG	Existing Homes	Residential Income-Eligible	Pipe Insulation	1.00
PSEG	Existing Homes	Residential Income-Eligible	ShowerStart	0.94

IOU	Program	Sub Program	Measure	ISR
PSEG	Existing Homes	Residential Income-Eligible	Smart Thermostat	1.00
PSEG	Existing Homes	Residential Income-Eligible	Water Heater Setback	1.00
SJG	EE Products	Appliance Rebates	Clothes Dryer	1.00
SJG	EE Products	Appliance Rebates	Clothes Washer (Tier 1)	1.00
SJG	EE Products	Appliance Rebates	Clothes Washer (Tier 2)	1.00
SJG	EE Products	HVAC	Central Air Conditioners (Tier 1)	0.96
SJG	EE Products	HVAC	Gas Boiler	1.00
SJG	EE Products	HVAC	Gas Combination Heater	0.92
SJG	EE Products	HVAC	Gas Furnace	0.95
SJG	EE Products	HVAC	Gas Furnace with Water Heater	0.94
SJG	EE Products	HVAC	Gas Storage Tank Water Heater	0.97
SJG	EE Products	HVAC	Tankless Water Heater	0.97
SJG	EE Products	Online Marketplace	Bathroom Aerator	0.85
SJG	EE Products	Online Marketplace	Kitchen Aerator	0.84
SJG	EE Products	Online Marketplace	Low-Flow Showerhead	0.69
SJG	EE Products	Online Marketplace	Smart thermostat	0.96
SJG	Existing Homes	QHEC	Advanced Power Strips	0.91
SJG	Existing Homes	QHEC	LED Bulb	0.98
SJG	Existing Homes	QHEC	Pipe Insulation	0.95

14 APPENDIX K: DHW AND SPACE HEAT FUEL SPLIT

The values below should be used when customer DHW or space heat fuel type is unknown. If a measure is not listed in Table 14-1, use default values presented in Table 14-2 or in measure section.

Table 14-1 Fuel Split by Program and Measure

IOU	Program	Measure	Parameter	Value
ACE	Appliance Rebates	Any	% gas water heat	0.63
ACE	Appliance Rebates	Any	% elec water heat	0.30
ACE	Appliance Rebates	Any	% gas space heat	0.78
ACE	Appliance Rebates	Any	% elec space heat	0.09
ACE	HVAC Rebates	Any	% gas space heat	0.83
ACE	HVAC Rebates	Any	% elec space heat	0.17
ACE	Marketplace	Any	% gas space heat	0.66
ACE	Marketplace	Any	% elec space heat	0.19
ACE	Marketplace	Any	% gas water heat	0.57
ACE	Marketplace	Any	% elec water heat	0.31
ETG	Down-stream	Any	% gas water heat	0.94
ETG	Down-stream	Any	% elec water heat	0.06
ETG	Down-stream	Any	% gas space heat	0.96
ETG	Down-stream	Any	% elec space heat	0.04
ETG	HER	Any	% gas water heat	0.87
ETG	HER	Any	% elec water heat	0.13
ETG	HER	Any	% gas space heat	0.90
ETG	HER	Any	% elec space heat	0.10
ETG	Marketplace	Any	% gas water heat	0.86
ETG	Marketplace	Any	% elec water heat	0.14
ETG	Marketplace	Any	% gas space heat	0.91
ETG	Marketplace	Any	% elec space heat	0.09
ETG	Non-Participant	Any	% gas water heat	0.80
ETG	Non-Participant	Any	% elec water heat	0.20
ETG	Non-Participant	Any	% gas space heat	0.84
ETG	Non-Participant	Any	% elec space heat	0.16
ETG	QHEC	Any	% gas water heat	0.84

IOU	Program	Measure	Parameter	Value
ETG	QHEC	Any	% elec water heat	0.16
ETG	QHEC	Any	% gas space heat	0.95
ETG	QHEC	Any	% elec space heat	0.05
JCPL	Appliance Rebates	Clothes Washer	% elec water heat	0.53
JCPL	Appliance Rebates	Clothes Washer	% gas water heat	0.47
JCPL	EE Kits	Faucet Aerator	% elec water heat	0.68
JCPL	EE Kits	Faucet Aerator	% gas water heat	0.32
JCPL	EE Kits	Shower Head	% elec water heat	0.71
JCPL	EE Kits	Shower Head	% gas water heat	0.29
PSEG	EE Kits	Any	% elec space heat	0.38
PSEG	EE Kits	Any	% gas space heat	0.61
PSEG	EE Kits	Any	% elec water heat	0.36
PSEG	EE Kits	Any	% gas water heat	0.63
PSEG	Online Marketplace	Any	% elec space heat	0.11
PSEG	Online Marketplace	Any	% gas space heat	0.86
PSEG	Online Marketplace	Any	% elec water heat	0.13
PSEG	Online Marketplace	Any	% gas water heat	0.87
SJG	Down-stream	Any	% gas water heat	0.86
SJG	Down-stream	Any	% elec water heat	0.14
SJG	Down-stream	Any	% gas space heat	0.94
SJG	Down-stream	Any	% elec space heat	0.06
SJG	HER	Any	% gas water heat	0.92
SJG	HER	Any	% elec water heat	0.08
SJG	HER	Any	% gas space heat	0.92
SJG	HER	Any	% elec space heat	0.08
SJG	Marketplace	Any	% gas water heat	0.83
SJG	Marketplace	Any	% elec water heat	0.17
SJG	Marketplace	Any	% gas space heat	0.93
SJG	Marketplace	Any	% elec space heat	0.07
SJG	Non-Participant	Any	% gas water heat	0.83
SJG	Non-Participant	Any	% elec water heat	0.17
SJG	Non-Participant	Any	% gas space heat	0.90

IOU	Program	Measure	Parameter	Value
SJG	Non-Participant	Any	% elec space heat	0.10
SJG	QHEC	Any	% gas water heat	0.88
SJG	QHEC	Any	% elec water heat	0.12
SJG	QHEC	Any	% gas space heat	0.91
SJG	QHEC	Any	% elec space heat	0.09

Table 14-2 Default Fuel Split Values

IOU	Program	Measure	Parameter	Value
Any	Any	Clothes washer	% gas water heat	0.69
Any	Any	Clothes washer	% elec water heat	0.31
Any	Any	Dishwasher	% elec water heat	0.20
Any	Any	Dishwasher	% gas water heat	0.54
Any	Any	Smart Thermostat	% elec space heat	0.15
Any	Any	Smart Thermostat	% gas space heat	0.85
Any	Any	Aerators or showerheads	% elec water heat	0.25
Any	Any	Aerators or showerheads	% gas water heat	0.71
Any	Any	Thermostatic showerhead	% elec water heat	0.18
Any	Any	Thermostatic showerhead	% gas water heat	0.82
Any	Any	Pipe insulation	% elec water heat	0.18
Any	Any	Pipe insulation	% gas water heat	0.82

15 APPENDIX L: LIGHTING WATTAGES

15.1 C&I MIDSTREAM LIGHTING BASELINE WATTAGES

This section provides baseline wattages for Midstream lighting fixtures, built by NJ Utilities a baseline wattage table for these fixtures by using Pennsylvania, New Jersey, Illinois and Mid-Atlantic TRMs as reference.

Fixture / Lamp	Baseline Watts	Fixture Type	Reference
Energy Star LED Fixture - Accent Light Line Voltage <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Accent Light Line Voltage >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Accent Light Line Voltage 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Bath Vanity <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Bath Vanity >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Bath Vanity 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Ceiling Mount <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Ceiling Mount >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Ceiling Mount 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Close to Ceiling Mount <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Close to Ceiling Mount >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Close to Ceiling Mount 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Cove Mount <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Cove Mount >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Cove Mount 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM

Fixture / Lamp	Baseline Watts	Fixture Type	Reference
Energy Star LED Fixture - Decorative Pendant <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Decorative Pendant >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Decorative Pendant 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Downlight Pendant <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Downlight Pendant >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Downlight Pendant 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Downlight Surface Mount <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Downlight Surface Mount >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Downlight Surface Mount 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Linear Strip <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Linear Strip >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Linear Strip 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Outdoor Pole-Mount <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Outdoor Pole-Mount >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Outdoor Pole-Mount 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Pendant <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Recessed Downlight <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Recessed Downlight >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Recessed Downlight 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM

Fixture / Lamp	Baseline Watts	Fixture Type	Reference
Energy Star LED Fixture - Security <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Security >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Security 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Solid State Retrofit <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Solid State Retrofit >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Solid State Retrofit 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Under Cabinet <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Under Cabinet >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Under Cabinet 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Wall Sconces <1,499 Lumens	51.875	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Wall Sconces >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Wall Sconces 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Wrapped Lens >3,000 Lumens	200	Energy Star Fixtures	Custom table based on IL TRM
Energy Star LED Fixture - Wrapped Lens 1,500 to 2,999 Lumens	136.25	Energy Star Fixtures	Custom table based on IL TRM
HID Replacement Lamp <=125W	171	HID Lamps	MidAtlantic TRM
HID Replacement Lamp >250W	452	HID Lamps	MidAtlantic TRM
HID Replacement Lamp>125W - <=250W	288	HID Lamps	MidAtlantic TRM
1 x 4 LED integrated retrofit kit 1500 - 3000 Lumens	30.06	Troffers	IL TRM
1 x 4 LED integrated retrofit kit 3001 - 4500 Lumens	59.48	Troffers	IL TRM
1 x 4 LED integrated retrofit kit 4501 - 6000 Lumens	96.24	Troffers	IL TRM
1 x 4 LED new luminaire 3001 - 4500 Lumens	59.48	Troffers	IL TRM
1 x 4 LED new luminaire 1500 - 3000 Lumens	30.06	Troffers	IL TRM

Fixture / Lamp	Baseline Watts	Fixture Type	Reference
1 x 4 LED new luminaire 4501 - 6000 Lumens	96.24	Troffers	IL TRM
2 x 2 LED integrated retrofit kit 2000-3500 Lumens	59.48	Troffers	IL TRM
2 x 2 LED integrated retrofit kit 3501 - 5000 Lumens	96.24	Troffers	IL TRM
2 x 2 LED new luminaire 2000-3500 Lumens	59.48	Troffers	IL TRM
2 x 2 LED new luminaire 3501 - 5000 Lumens	96.24	Troffers	IL TRM
2 x 4 LED integrated retrofit kit 3000 - 4500 Lumens	59.48	Troffers	IL TRM
2 x 4 LED integrated retrofit kit 6001 - 7500 Lumens	128.32	Troffers	IL TRM
2 x 4 LED integrated retrofit kit 4501 - 6000 Lumens	96.24	Troffers	IL TRM
2 x 4 LED new luminaire 3000-4500 Lumens	59.48	Troffers	IL TRM
2 x 4 LED new luminaire 4501-6000 Lumens	96.24	Troffers	IL TRM
2 x 4 LED new luminaire 6001-7500 Lumens	128.32	Troffers	IL TRM
U -Bend Lamp 1500-2000 Lumens	29.5	Troffers	IL TRM
U -Bend Lamp 2001 - 3276 Lumens	54	Troffers	IL TRM
2G11 Base Lamps 1350-1834 Lumens	26	Pin Lamps	MidAtlantic TRM
2G11 Base Lamps 1835-2549 Lumens	32	Pin Lamps	MidAtlantic TRM
2G11 Base Lamps 2550-3199 Lumens	42	Pin Lamps	MidAtlantic TRM
Hortizontally-Mounted Lamps 1350-1834 Lumens	26	Pin Lamps	MidAtlantic TRM
Hortizontally-Mounted Lamps 1835-2549 Lumens	32	Pin Lamps	MidAtlantic TRM
Hortizontally-Mounted Lamps 760-934 Lumens	13	Pin Lamps	MidAtlantic TRM
Hortizontally-Mounted Lamps 935-1349 Lumens	18	Pin Lamps	MidAtlantic TRM
Vertically-Mounted Lamps 1350-1834 Lumens	26	Pin Lamps	MidAtlantic TRM
Vertically-Mounted Lamps 1835-2549 Lumens	32	Pin Lamps	MidAtlantic TRM
Vertically-Mounted Lamps 760-934 Lumens	13	Pin Lamps	MidAtlantic TRM
Vertically-Mounted Lamps 935-1349 Lumens	18	Pin Lamps	MidAtlantic TRM
Refrigerated Case Lighting <4'	2x the wattage of the LED model #	Refrigerated Case Lighting	NJ TRM
Refrigerated Case Lighting ≥4ft - <5ft	2x the wattage of the LED model #	Refrigerated Case Lighting	NJ TRM
Refrigerated Case Lighting ≥5ft - <6ft	2x the wattage of the LED model #	Refrigerated Case Lighting	NJ TRM
Refrigerated Case Lighting ≥6ft	2x the wattage of the LED model #	Refrigerated Case Lighting	NJ TRM
Exit Signs - Double	16.4	Exit	MidAtlantic TRM

Fixture / Lamp	Baseline Watts	Fixture Type	Reference
Exit Signs - Single	16.4	Exit	MidAtlantic TRM

15.2 FIXTURE WATTAGES BY TYPE

The values below are taken from Rhode Island TRM, 2020 Appendix A, table 3.

Table 15-1 Fixture Wattages By Type

Fixture Code	Description	Rated Watts
LED Exit Signs		
1E0002	2.0 WATT LED	2
1E0003	3.0 WATT LED	3
1E0005	5.0 WLED	5
1E0005C	0.5 WATT LEC	0.5
1E0008	8.0 WLED	8
1E0015	1.5 WATT LED	1.5
Compact Fluorescents		
1C0005S	5W COMPACT HW	7
1C0007S	7W COMPACT HW	9
1C0009S	9W COMPACT HW	11
1C0011S	11W COMPACT HW	13
1C0013S	13W COMPACT HW	15
1C0018E	18W COMPACT HW ELIG	20
1C0018S	18W COMPACT HW	20
1C0022S	22W COMPACT HW	24
1C0023E	1/23W COMPACT HW ELIG	25
1C0026E	26W COMPACT HW ELIG	28
1C0026S	26W COMPACT HW	28
1C0028S	28W COMPACT HW	30
1C0032E	32W COMPACT HW ELIG	34
1C0032S	32W CIRCLINE HW	34
1C0042E	1/42W COMPACT HW ELIG	48

Fixture Code	Description	Rated Watts
1C0044S	44W CIRCLINE HW	46
1C0057E	1/57W COMPACT HW ELIG	65
2C0005S	2/5W COMPACT HW	14
2C0007S	2/7W COMPACT HW	18
2C0009S	2/9W COMPACT HW	22
2C0011S	2/11W COMPACT HW	26
2C0013E	2/13W COMPACT HW ELIG	28
2C0013S	2/13W COMPACT HW	30
2C0018E	2/18W COMP. HW ELIG	40
2C0026E	2/26W COMP. HW ELIG	54
2C0032E	2/32W COMPACT HW ELIG	68
2C0042E	2/42W COMPACT HW ELIG	100
3C0009S	3/9W COMPACT HW	33
3C0013S	3/13W COMPACT HW	45
3C0018E	3/18W COMPACT HW ELIG	60
3C0026E	3/26W COMPACT HW ELIG	82
3C0032E	3/32W COMPACT HW ELIG	114
3C0042E	3/42W COMPACT HW ELIG	141
4C0013S	4/13W COMPACT HW	60
4C0018E	4/18W COMPACT HW ELIG	80
4C0026E	4/26W COMPACT HW ELIG	108
4C0032E	4/32W COMPACT HW ELIG	152
4C0042E	4/42W COMPACT HW ELIG	188
6C0026E	6/26W COMPACT HW ELIG	162
6C0032E	6/32W COMPACT HW ELIG	228
6C0042E	6/42W COMPACT HW ELIG	282
8C0026E	8/26W COMPACT HW ELIG	216
8C0032E	8/32W COMPACT HW ELIG	304
8C0042E	8/42W COMPACT HW ELIG	376
T5 Systems		
10F54HSE	10L4’ 54W T5HO/ELIG	585

Fixture Code	Description	Rated Watts
1F14SSE	1L2’ 14W T5/ELIG	16
1F21SSE	1L3’ 21W T5/ELIG	24
1F24HSE	1L2’ 24W T5HO/ELIG	29
1F28SSE	1L4’ 28W T5/ELIG	32
1F39HSE	1L3’ 39W T5HO/ELIG	42
1F54HSE	1L4’ 54W T5HO/ELIG	59
2F14SSE	2L2’ 14W T5/ELIG	32
2F21SSE	2L3’ 21W T5/ELIG	47
2F24HSE	2L2’ 24W T5HO/ELIG	52
2F28SSE	2L4’ 28W T5/ELIG	63
2F39HSE	2L3’ 39W T5HO/ELIG	85
2F54HSE	2L4’ 54W T5HO/ELIG	117
3F24HSE	3L2’ 24W T5HO/ELIG	80
3F28SSE	3L4’ 28W T5 ELIG	95
3F54HSE	3L4’ 54W T5HO/ELIG	177
4F54HSE	4L4’ 54W T5HO/ELIG	234
5F54HSE	5L4’ 54W T5HO/ELIG	294
6F54HSE	6L4’ 54W T5HO/ELIG	351
8F54HSE	8L4’ 54W T5HO/ELIG	468
Two Foot High Efficient T8 Systems		
1F17ESH	1L2’ 17W T8EE/ELEE HIGH PWR	20
1F17ESL	1L2’ 17W T8EE/ELEE LOW PWR	14
1F17ESN	1L2’ 17W T8EE/ELEE	17
1F28BXE	1L2’ F28BX/ELIG	32
2F17ESH	2L2’ 17W T8EE/ELEE HIGH PWR	40
2F17ESL	2L2’ 17W T8EE/ELEE LOW PWR	27
2F17ESN	2L2’ 17W T8EE/ELEE	32
2F28BXE	2L2’ F28BX/ELIG	63
3F17ESH	3L2’ 17W T8EE/ELEE HIGH PWR	61
3F17ESL	3L2’ 17W T8EE/ELEE LOW PWR	39
3F17ESN	3L2’ 17W T8EE/ELEE	46

Fixture Code	Description	Rated Watts
3F28BXE	3L2’ F28BX/ELIG	94
Three Foot High Efficient T8 Systems		
1F25ESH	1L3’ 25W T8EE/ELEE HIGH PWR	30
1F25ESL	1L3’ 25W T8EE/ELEE LOW PWR	21
1F25ESN	1L3’ 25W T8EE/ELEE	24
2F25ESH	2L3’ 25W T8EE/ELEE HIGH PWR	60
2F25ESL	2L3’ 25W T8EE/ELEE LOW PWR	40
2F25ESN	2L3’ 25W T8EE/ELEE	45
3F25ESH	3L3’ 25W T8EE/ELEE HIGH PWR	90
3F25ESL	3L3’ 25W T8EE/ELEE LOW PWR	58
3F25ESN	3L3’ 25W T8EE/ELEE	67
Four Foot High Efficient T8 Systems		
1F25EEE	1L4’ 25W T8EE/ELEE	22
1F25EEH	1L4’ 25W T8EE/ELEE HIGH PWR	30
1F25EEL	1L4’ 25W T8EE/ELEE LOW PWR	19
1F28EEE	1L4’ 28W T8EE/ELEE	24
1F28EEH	1L4’ 28W T8EE/ELEE HIGH PWR	33
1F28EEL	1L4’ 28W T8EE/ELEE LOW PWR	22
1F30EEE	1L4’ 30W T8EE/ELEE	26
1F30EEH	1L4’ 30W T8EE/ELEE HIGH PWR	36
1F30EEL	1L4’ 30W T8EE/ELEE LOW PWR	24
1F32EEE	1L4’ 32W T8EE/ELEE	28
1F32EEH	1L4’ 32W T8EE/ELEE HIGH PWR	38
1F32EEL	1L4’ 32W T8EE/ELEE LOW PWR	25
2F25EEE	2L4’ 25W T8EE/ELEE	43
2F25EEH	2L4’ 25W T8EE/ELEE HIGH PWR	57
2F25EEL	2L4’ 25W T8EE/ELEE LOW PWR	37
2F28EEE	2L4’ 28W T8EE/ELEE	48
2F28EEH	2L4’ 28WT8EE/ELEE HIGH PWR	64
2F28EEL	2L4’ 28W T8EE/ELEE LOW PWR	42
2F30EEE	2L4’ 30W T8EE/ELEE	52

Fixture Code	Description	Rated Watts
2F30EEH	2L4’ 30WT8EE/ELEE HIGH PWR	69
2F30EEL	2L4’ 30W T8EE/ELEE LOW PWR	45
2F32EEE	2L4’ 32W T8EE/ELEE	53
2F32EEH	2L4’ 32W T8EE/ELEE HIGH PWR	73
2F32EEL	2L4’ 32W T8EE/ELEE LOW PWR	47
3F25EEE	3L4’ 25W T8EE/ELEE	64
3F25EEH	3L4’ 25W T8EE/ELEE HIGH PWR	86
3F25EEL	3L4’ 25W T8EE/ELEE LOW PWR	57
3F28EEE	3L4’ 28W T8EE/ELEE	72
3F28EEH	3L4’ 28W T8EE/ELEE HIGH PWR	96
3F28EEL	3L4’ 28W T8EE/ELEE LOW PWR	63
3F30EEE	3L4’ 30W T8EE/ELEE	77
3F30EEH	3L4’ 30W T8EE/ELEE HIGH PWR	103
3F30EEL	3L4’ 30W T8EE/ELEE LOW PWR	68
3F32EEE	3L4’ 32W T8EE/ELEE	82
3F32EEH	3L4’ 32W T8EE/ELEE HIGH PWR	109
3F32EEL	3L4’ 32W T8EE/ELEE LOW PWR	72
4F25EEE	4L4’ 25W T8EE/ELEE	86
4F25EEH	4L4’ 25W T8EE/ELEE HIGH PWR	111
4F25EEL	4L4’ 25W T8EE/ELEE LOW PWR	75
4F28EEE	4L4’ 28W T8EE/ELEE	94
4F28EEH	4L4’ 28W T8EE/ELEE HIGH PWR	126
4F28EEL	4L4’ 28W T8EE/ELEE LOW PWR	83
4F30EEE	4L4’ 30W T8EE/ELEE	101
4F30EEH	4L4’ 30W T8EE/ELEE HIGH PWR	133
4F30EEL	4L4’ 30W T8EE/ELEE LOW PWR	89
4F32EEE	4L4’ 32W T8EE/ELEE	107
4F32EEH	4L4’ 32W T8EE/ELEE HIGH PWR	141
4F32EEL	4L4’ 32W T8EE/ELEE LOW PWR	95
6F32EEE	6L4’ 32W T8EE/ELEE	168
6F32EEH	6L4’ 32W T8EE/ELEE HIGH PWR	218

Fixture Code	Description	Rated Watts
6F32EEL	6L4’ 32W T8EE/ELEE LOW PWR	146
Eight Foot T8 Systems		
1F59SSE	1L8’ T8/ELIG	60
1F80SSE	1L8’ T8 HO/ELIG	85
2F59SSE	2L8’ T8/ELIG	109
2F59SSL	2L8’ T8/ELIG LOW PWR	100
2F80SSE	2L8’ T8 HO/ELIG	160
LED Lighting Fixtures		
1E0002	2.0 WATT LED	2
1E0003	3.0 WATT LED	3
1E0015	1.5 WATT LED	1.5
1E0105	10.5 WATT LED	10.5
1L002	2 WATT LED	2
1L003	3 WATT LED	3
1L004	4 WATT LED	4
1L005	5 WATT LED	5
1L006	6 WATT LED	6
1L007	7 WATT LED	7
1L008	8 WATT LED	8
1L009	9 WATT LED	9
1L010	10 WATT LED	10
1L011	11 WATT LED	11
1L012	12 WATT LED	12
1L013	13 WATT LED	13
1L014	14 WATT LED	14
1L015	15 WATT LED	15
1L016	16 WATT LED	16
1L017	17 WATT LED	17
1L018	18 WATT LED	18
1L019	19 WATT LED	19
1L020	20 WATT LED	20

Fixture Code	Description	Rated Watts
1L021	21 WATT LED	21
1L022	22 WATT LED	22
1L023	23 WATT LED	23
1L024	24 WATT LED	24
1L025	25 WATT LED	25
1L026	26 WATT LED	26
1L027	27 WATT LED	27
1L028	28 WATT LED	28
1L029	29 WATT LED	29
1L030	30 WATT LED	30
1L031	31 WATT LED	31
1L032	32 WATT LED	32
1L033	33 WATT LED	33
1L034	34 WATT LED	34
1L035	35 WATT LED	35
1L036	36 WATT LED	36
1L037	37 WATT LED	37
1L038	38 WATT LED	38
1L039	39 WATT LED	39
1L040	40 WATT LED	40
1L041	41 WATT LED	41
1L042	42 WATT LED	42
1L043	43 WATT LED	43
1L044	44 WATT LED	44
1L045	45 WATT LED	45
1L046	46 WATT LED	46
1L047	47 WATT LED	47
1L048	48 WATT LED	48
1L049	49 WATT LED	49
1L050	50 WATT LED	50
1L051	51 WATT LED	51

Fixture Code	Description	Rated Watts
1L052	52 WATT LED	52
1L053	53 WATT LED	53
1L054	54 WATT LED	54
1L055	55 WATT LED	55
1L056	56 WATT LED	56
1L057	57 WATT LED	57
1L058	58 WATT LED	58
1L059	59 WATT LED	59
1L060	60 WATT LED	60
1L061	61 WATT LED	61
1L062	62 WATT LED	62
1L063	63 WATT LED	63
1L064	64 WATT LED	64
1L065	65 WATT LED	65
1L066	66 WATT LED	66
1L067	67 WATT LED	67
1L068	68 WATT LED	68
1L069	69 WATT LED	69
1L070	70 WATT LED	70
1L071	71 WATT LED	71
1L072	72 WATT LED	72
1L073	73 WATT LED	73
1L074	74 WATT LED	74
1L075	75 WATT LED	75
1L076	76 WATT LED	76
1L077	77 WATT LED	77
1L078	78 WATT LED	78
1L079	79 WATT LED	79
1L080	80 WATT LED	80
1L081	81 WATT LED	81
1L082	82 WATT LED	82

Fixture Code	Description	Rated Watts
1L083	83 WATT LED	83
1L084	84 WATT LED	84
1L085	85 WATT LED	85
1L086	86 WATT LED	86
1L087	87 WATT LED	87
1L088	88 WATT LED	88
1L089	89 WATT LED	89
1L090	90 WATT LED	90
1L091	91 WATT LED	91
1L092	92 WATT LED	92
1L093	93 WATT LED	93
1L094	94 WATT LED	94
1L095	95 WATT LED	95
1L096	96 WATT LED	96
1L097	97 WATT LED	97
1L098	98 WATT LED	98
1L099	99 WATT LED	99
1L100	100 WATT LED	100
1L110	110 WATT LED	110
1L116	116 WATT LED	116
1L120	120 WATT LED	120
1L125	125 WATT LED	125
1L130	130 WATT LED	130
1L135	135 WATT LED	135
1L140	140 WATT LED	140
1L145	145 WATT LED	145
1L150	150 WATT LED	150
1L155	155 WATT LED	155
1L160	160 WATT LED	160
1L165	165 WATT LED	165
1L170	170 WATT LED	170

Fixture Code	Description	Rated Watts
1L175	175 WATT LED	175
1L180	180 WATT LED	180
1L185	185 WATT LED	185
1L190	190 WATT LED	190
1L200	200 WATT LED	200
1L210	210 WATT LED	210
1L220	220 WATT LED	220
1L240	240 WATT LED	240
1L376	4X94 WATT LED	376
1L405	3x135 WATT LED	405
Electronic Metal Halide Lamps		
1M0150E	150W METAL HALIDE EB	160
1M0200E	200W METAL HALIDE EB	215
1M0250E	250W METAL HALIDE EB	270
1M0320E	320W METAL HALIDE EB	345
1M0350E	350W METAL HALIDE EB	375
1M0400E	400W METAL HALIDE EB	430
1M0450E	400W METAL HALIDE EB	480
MH Track Lighting		
1M0020E	20W MH SPOT	25
1M0025E	25W MH SPOT	25
1M0035E	35W MH SPOT	44
1M0039E	39W MH SPOT	47
1M0050E	50W MH SPOT	60
1M0070E	70W MH SPOT	80
1M0100E	100W MH SPOT	111
1M0150E	150W MH SPOT	162
Incandescent Lamps		
1I0015	15W INC	15
1I0020	20W INC	20
1I0025	25W INC	25

Fixture Code	Description	Rated Watts
1I0034	34W INC	34
1I0036	36W INC	36
1I0040	40W INC	40
1I0042	42W INC	42
1I0045	45W INC	45
1I0050	50W INC	50
1I0052	52W INC	52
1I0054	54W INC	54
1I0055	55W INC	55
1I0060	60W INC	60
1I0065	65W INC	65
1I0067	67W INC	67
1I0069	69W INC	69
1I0072	72W INC	72
1I0075	75W INC	75
1I0080	80W INC	80
1I0085	85W INC	85
1I0090	90W INC	90
1I0093	93W INC	93
1I0100	100W INC	100
1I0120	120W INC	120
1I0125	125W INC	125
1I0135	135W INC	135
1I0150	150W INC	150
1I0200	200W INC	200
1I0300	300W INC	300
1I0448	448W INC	448
1I0500	500W INC	500
1I0750	750W INC	750
1I1000	1000W INC	1000
1I1500	1500W INC	1500

Fixture Code	Description	Rated Watts
Low Voltage Halogen Fixture (includes Transformer)		
1R0020	20W LV HALOGEN FIXT	30
1R0025	25W LV HALOGEN FIXT	35
1R0035	35W LV HALOGEN FIXT	45
1R0042	42W LV HALOGEN FIXT	52
1R0050	50W LV HALOGEN FIXT	60
1R0065	65W LV HALOGEN FIXT	75
1R0075	75W LV HALOGEN FIXT	85
Halogen/Quartz Lamps		
1T0035	35W HALOGEN LAMP	35
1T0040	40W HALOGEN LAMP	40
1T0042	42W HALOGEN LAMP	42
1T0045	45W HALOGEN LAMP	45
1T0047	47W HALOGEN LAMP	47
1T0050	50W HALOGEN LAMP	50
1T0052	52W HALOGEN LAMP	52
1T0055	55W HALOGEN LAMP	55
1T0060	60W HALOGEN LAMP	60
1T0072	72W HALOGEN LAMP	72
1T0075	75W HALOGEN LAMP	75
1T0090	90W HALOGEN LAMP	90
1T0100	100W HALOGEN LAMP	100
1T0150	150W HALOGEN LAMP	150
1T0200	200W HALOGEN LAMP	200
1T0250	250W HALOGEN LAMP	250
1T0300	300W HALOGEN LAMP	300
1T0350	350W HALOGEN LAMP	350
1T0400	400W HALOGEN LAMP	400
1T0425	425W HALOGEN LAMP	425
1T0500	500W HALOGEN LAMP	500
1T0750	750W HALOGEN LAMP	750

Fixture Code	Description	Rated Watts
1T0900	900W HALOGEN LAMP	900
1T1000	1000W HALOGEN LAMP	1000
1T1200	1200W HALOGEN LAMP	1200
1T1500	1500W HALOGEN LAMP	1500
2T0075	2-75W HALOGEN LAMP	1800
	Mercury Vapor (MV)	
1V0040S	40W MERCURY	50
1V0050S	50W MERCURY	75
1V0075S	75W MERCURY	95
1V0100S	100W MERCURY	120
1V0175S	175W MERCURY	205
1V0250S	250W MERCURY	290
1V0400S	400W MERCURY	455
1V0700S	700W MERCURY	775
1V1000S	1000W MERCURY	1075
2V0400S	2/400W MERCURY	880
	Low Pressure Sodium (LPS)	
1L0035S	35W LPS	60
1L0055S	55W LPS	85
1L0090S	90W LPS	130
1L0135S	135W LPS	180
1L0180S	180W LPS	230
	High Pressure Sodium (HPS)	
1H0035S	35W HPS	45
1H0050S	50W HPS	65
1H0070S	70W HPS	90
1H0100S	100W HPS	130
1H0150S	150W HPS	190
1H0200S	200W HPS	240
1H0225S	225W HPS	275
1H0250S	250W HPS	295

Fixture Code	Description	Rated Watts
1H0310S	310W HPS	350
1H0360S	360W HPS	435
1H0400S	400W HPS	460
1H0600S	600W HPS	675
1H0750S	750W HPS	835
1H1000S	1000W HPS	1085
Metal Halide (MH)		
1M0032S	32W METAL HALIDE	40
1M0050S	50W METAL HALIDE	65
1M0070S	70W METAL HALIDE	95
1M0100S	100W METAL HALIDE	120
1M0150E	150W METAL HALIDE EB	160
1M0150S	150W METAL HALIDE	190
1M0175S	175W METAL HALIDE	205
1M0200E	200W METAL HALIDE EB	215
1M0250E	250W METAL HALIDE EB	270
1M0250S	250W METAL HALIDE	295
1M0320E	320W METAL HALIDE EB	345
1M0350E	350W METAL HALIDE EB	375
1M0360S	360W METAL HALIDE	430
1M0400E	400W METAL HALIDE EB	430
1M0400S	400W METAL HALIDE	455
1M0450E	400W METAL HALIDE EB	480
1M0750S	750W METAL HALIDE	825
1M1000S	1000W METAL HALIDE	1075
1M1500S	1500W METAL HALIDE	1615
1M1800S	1800W METAL HALIDE	1875
Pulse Start Metal Halide Lamp/Ballast		
1M0100P	100W MH CWA	128
1M0100R	100W MH LINEAR	118
1M0150P	150W MH CWA	190

Fixture Code	Description	Rated Watts
1M0150R	150W MH LINEAR	172
1M0175P	175W MH CWA	208
1M0175R	175W MH LINEAR	190
1M0200P	200W MH CWA	232
1M0200R	200W MH LINEAR	218
1M0250P	250W MH CWA	288
1M0250R	250W MH LINEAR	265
1M0300P	300W MH CWA	342
1M0300R	300W MH LINEAR	324
1M0320P	320W MH CWA	365
1M0320R	320W MH LINEAR	345
1M0350P	350W MH CWA	400
1M0350R	350W MH LINEAR	375
1M0400P	400W MH CWA	455
1M0400R	400W MH LINEAR	430
1M0450P	450W MH CWA	508
1M0450R	450W MH LINEAR	480
1M0750P	750W MH CWA	815
1M0750R	750W MH LINEAR	805
1M1000P	1000W MH CWA	1080
Two Foot T8/T12 Systems		
12F40BE	12L2’ F40BX/ELIG	408
12F50BE	12L2’ F50BX/ELIG	648
12F55BE	12L2’ F55BX/ELIG	672
1F55BXE	1L2’ F55BX/ELIG	56
1F80BXE	1L2’ F80BXE/ELIG	90
2F17SSE	2L2’ 17W T8/ELIG	37
2F17SSL	2L2’ 17W T8/ELIG LOW POWER	27
2F17SSM	2L2’ 17W T8/EEMAG	45
2F24HSS	2L2’ 24 T12HO/STD/STD	85
2F40BXE	2L2’ F40BX/ELIG	72

Fixture Code	Description	Rated Watts
2F50BXE	2L2’ F50BX/ELIG	108
2F55BXE	2L2’55BXE/ELIG	112
3F17SSE	3L2’ 17W T8/ELIG	53
3F17SSL	3L2’ 17W T8/ELIG LOW POWER	39
3F40BXE	3L2’ F40BX/ELIG	102
3F50BXE	3L2’ F50BX/ELIG	162
3F55BXE	3L2’ F55BX/ELIG	168
4F17SSE	4L2’ 17W T8/ELIG	62
4F36BXE	4L2’ F36BX/ELIG	148
4F40BXE	4L2’ F40BX/ELIG	144
4F50BXE	4L2’ F50BX/ELIG	216
4F55BXE	4L2’ F55BX/ELIG	224
5F40BXE	5L2’ F40BX/ELIG	190
5F50BXE	5L2’ F50BX/ELIG	270
5F55BXE	5L2’ F55BX/ELIG	280
6F36BXE	6L2’ F36BX/ELIG	212
6F40BXE	6L2’ F40BX/ELIG	204
6F50BXE	6L2’ F50BX/ELIG	324
6F55BXE	6L2’ F55BX/ELIG	336
8F36BXE	8L2’ F36BX/ELIG	296
8F40BXE	8L2’ F40BX/ELIG	288
8F50BXE	8L2’ F50BX/ELIG	432
8F55BXE	8L2’ F55BX/ELIG	448
9F36BXE	9L2’ F36BX/ELIG	318
9F40BXE	9L2’ F40BX/ELIG	306
9F50BXE	9L2’ F50BX/ELIG	486
9F55BXE	9L2’ F55BX/ELIG	504
Three Foot T8/T12 Systems		
1F25SSE	1L3’ 25W T8/ELIG	24
1F30SEM	1L3’ 30W T12 EE/EEMAG	38
1F30SES	1L3’ 30W T12 EE/STD	42

Fixture Code	Description	Rated Watts
1F30SSS	1L3’ 30W T12 STD/STD	46
2F25SSE	2L3’ 25W T8/ELIG	47
2F25SSM	2L3’ 25W T8/EEMAG	65
2F30SEE	2L3’ 30W T12 EE/ELIG	49
2F30SEM	2L3’ 30W T12 EE/EEMAG	66
2F30SES	2L3’ 30W T12 EE/STD	73
2F30SSS	2L3’ 30W T12 STD/STD	80
3F25SSE	3L3’ 25W T8/ELIG	68
3F30SES	3L3’ 30W T12 EE/STD	127
3F30SSS	3L3’ 30W T12 STD/STD	140
4F25SSE	4L3’ 25W T8/ELIG	88
Four Foot F48		
1F48HES	1L4’ F48HO/EE/STD	80
1F48HSS	1L4’ F48HO/STD/STD	85
1F48SES	1L4’ F48T12EE/STD	50
1F48SSS	1L4’ F48T12/STD	60
1F48VES	1L4’ F48VHO/EE/STD	123
1F48VSS	1L4’ F48VHO/STD/STD	138
2F48HES	2L4’ F48HO/EE/STD	135
2F48HSS	2L4’ F48HO/STD/STD	145
2F48SES	2L4’ F48T12EE/STD	82
2F48SSS	2L4’ F48T12/STD	102
2F48VES	2L4’ F48VHO/EE/STD	210
2F48VSS	2L4’ F48VHO/STD/STD	240
3F48HES	3L4’ F48HO/EE/STD	215
3F48HSS	3L4’ F48HO/STD/STD	230
3F48SES	3L4’ F48T12EE/STD	132
3F48SSS	3L4’ F48T12/STD	162
3F48VES	3L4’ F48VHO/EE/STD	333
3F48VSS	3L4’ F48VHO/STD/STD	378
4F48HES	4L4’ F48HO/EE/STD	270

Fixture Code	Description	Rated Watts
4F48HSS	4L4' F48HO/STD/STD	290
4F48SES	4L4' F48T12EE/STD	164
4F48SSS	4L4' F48T12/STD	204
4F48VES	4L4' F48VHO/EE/STD	420
4F48VSS	4L4' F48VHO/STD/STD	480
	Four Foot T12 Systems	
1F40SEE	1L4' EE/ELIG	38
1F40SEM	1L4' EE/EEMAG	40
1F40SES	1L4' EE/STD	50
1F40SSE	1L4' STD/ELIG	46
1F40SSM	1L4' STD/EEMAG	50
1F40SSS	1L4' STD/STD	57
1F48SES	1L4' F48T12EE/STD	50
1F48SSS	1L4' F48T12/STD	60
2F40SEE	2L4' EE/ELIG	60
2F40SEM	2L4' EE/EEMAG	70
2F40SES	2L4' EE/STD	80
2F40SSE	2L4' STD/ELIG	72
2F40SSM	2L4' STD/EEMAG	86
2F40SSS	2L4' STD/STD	94
2F48SES	2L4' F48T12EE/STD	82
2F48SSS	2L4' F48T12/STD	102
3F40SEE	3L4' EE/ELIG	90
3F40SEM	3L4' EE/EEMAG	110
3F40SES	3L4' EE/STD	130
3F40SSE	3L4' STD/ELIG	110
3F40SSM	3L4' STD/EEMAG	136
3F40SSS	3L4' STD/STD	151
3F48SES	3L4' F48T12EE/STD	132
3F48SSS	3L4' F48T12/STD	162
4F40SEE	4L4' EE/ELIG	120

Fixture Code	Description	Rated Watts
4F40SEM	4L4’ EE/EEMAG	140
4F40SES	4L4’ EE/STD	160
4F40SSE	4L4’ STD/ELIG	144
4F40SSM	4L4’ STD/EEMAG	172
4F40SSS	4L4’ STD/STD	188
4F48SES	4L4’ F48T12EE/STD	164
4F48SSS	4L4’ F48T12/STD	204
6F40SSS	6L4’ STD/STD	282
	Four Foot T8 Systems	
1F32SSE	1L4’ T8/ELIG	30
1F32SSL	1L4 T8/ELIG LOW POWER	26
1F32SSM	1L4’ T8/EEMAG	37
2F32SSE	2L4’ T8/ELIG	60
2F32SSH	2L4’ T8/ELIG HIGH LMN	78
2F32SSL	2L4 T8/ELIG LOW PWR	52
2F32SSM	2L4’ T8/EEMAG	70
3F32SSE	3L4’ T8/ELIG	88
3F32SSH	3L4’ T8/ELIG HIGH LMN	112
3F32SSL	3L4 T8/ELIG LOW POWER	76
3F32SSM	3L4’ T8/EEMAG	107
4F32SSE	4L4’ T8/ELIG	112
4F32SSH	4L4’ T8/ELIG HIGH LMN	156
4F32SSL	4L4 T8/ELIG LOW PWR	98
4F32SSM	4L4’ T8/EEMAG	140
5F32SSE	5L4’ T8/ELIG	148
5F32SSH	5L4’ T8/ELIG HIGH LMN	190
6F32SSE	6L4’ T8/ELIG	174
8F32SSH	8L4’ T8/ELIG HIGH LMN	312
	Five Foot T8/T12 Systems	
1F40HSE	1L5’ HO/STD/ELIG	59
1F60HSM	1L5’ HO/STD/EEMAG	90

Fixture Code	Description	Rated Watts
1F60SSM	1L5'/STD/EEMAG	73
1F60TSM	1L5' T1OHO/STD/EEMAG	135
2F40HSE	2L5' HO/STD/ELIG	123
2F40TSE	2L5'T8/ELIG	68
2F60HSM	2L5' HO/STD/EEMAG	178
2F60SSM	2L5'/STD/EEMAG	122
3F40TSE	3L5'T8/ELIG	106
Six Foot T12 and T12HO Systems		
1F72HSE	1L6' T8HO/ELIG	80
1F72HSS	1L6' F72HO/STD/STD	113
1F72SSM	1L6' STD/EEMAG	80
1F72SSS	1L6' STD/STD	95
2F72HSE	2L6'T8 HO/ELIG	160
2F72HSM	2L6' F72HO/STD/EEMAG	193
2F72HSS	2L6' F72HO/STD	195
2F72SSM	2L6' STD/EEMAG	135
2F72SSS	2L6' STD/STD	173
Eight Foot T12VHO Systems		
1F96VES	1L8' VHO/EE/STD	200
1F96VSS	1L8' VHO/STD/STD	230
2F96VES	2L8' VHO/EE/STD	390
2F96VSS	2L8' VHO/STD/STD	450
3F96VES	3L8' VHO/EE/STD	590
3F96VSS	3L8' VHO/STD/STD	680
4F96VES	4L8' VHO/EE/STD	780
4F96VSS	4L8' VHO/STD/STD	900
Eight Foot T8 System		
1F59SSE	1L8' T8/ELIG	60
1F80SSE	1L8' T8 HO/ELIG	85
2F59SSE	2L8' T8/ELIG	109
2F59SSL	2L8' T8/ELIG LOW PWR	100

Fixture Code	Description	Rated Watts
2F80SSE	2L8’ T8 HO/ELIG	160
Eight Foot T12 System		
1F96SEE	1L8’ EE/ELIG	60
1F96SES	1L8’ EE/STD	83
1F96SSE	1L8’ STD/ELIG	70
1F96SSS	1L8’ STD/STD	100
2F96SEE	2L8’ EE/ELIG	109
2F96SEM	2L8’ EE/EEMAG	123
2F96SES	2L8’ EE/STD	138
2F96SSE	2L8’ STD/ELIG	134
2F96SSM	2L8’ STD/EEMAG	158
2F96SSS	2L8’ STD/STD	173
3F96SES	3L8’ EE/STD	221
3F96SSS	3L8’ STD/STD	273
4F96SEE	4L8’ EE/ELIG	218
4F96SEM	4L8’ EE/EEMAG	246
4F96SES	4L8’ EE/STD	276
4F96SSE	4L8’ STD/ELIG	268
4F96SSM	4L8’ STD/EEMAG	316
4F96SSS	4L8’ STD/STD	346

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
1	NJ Utilities Association (NJUA)	1.3	10	Introduction	Introduction	Introduction	Table 1-1	Need to label measure types (1,2,3) in table to support proceeding paragraph	Added numbering
2	NJ Utilities Association (NJUA)	1.5	11	Introduction	Introduction	Introduction	Whole-home	Section 1.5 addresses modeled energy savings. Consider providing additional guidance on model input parameter default values which are unknown and have an impact on modeled savings estimates. For example: default temperature setpoints. Approach to estimate heating and cooling efficiency of existing equipment whenever it is unknown default minimum R-values for shell. Very low r-values may have significant impact on savings Also consider proving guidance on reporting savings. These projects are early replacement yet there's no standardized way to report, for example, measure-level savings or EUL and RUL savings.	Simulation guidelines are out of scope for this update. Please address as a program implementation issue. Measure by measure savings requires cascading measure by measure simulations, which can be addressed as a program implementation issue. Added content addressing RUL and EUL.
3	NJ Utilities Association (NJUA)	1.8	12	Introduction	Introduction	Introduction	TOS	NJ TRM Sub team agreed to use TOS instead of Normal Replacement (NR) for terminology. There are still measures in this draft TRM that use NR instead of TOS. Suggest a scrub of NR in text and formulas and replace them with TOS. Consider adding to the TOS definition a sentence something like "TOS is sometimes referred to as normal replacement (NR)" just in case any references to NR remain by mistake.	Spot checked and all seem to have been changed. Did add the additional definition in case we missed any per recommendation.
4	NJ Utilities Association (NJUA)	1.9.1	13	Introduction	Introduction	Introduction	PJM Peak	The summer peak should align with PJM's manual 18b, page 39: *"The EE Performance Hours are between the hour ending 15:00 Eastern Prevailing Time (EPT) and the hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, of such Delivery Year, that is not a weekend or federal holiday."*	Languange in introduction updated
5	NJ Utilities Association (NJUA)	2.1.2	23	Residential	Appliances	Clothes Dryer	Low Income included in Market	The TRM Sub Committee agreed to remove Low Income from Market on all measures. There are several measures in the draft TRM that still have Low-Income listed under Market. Not all instances are called out in these comments. Need to do a global removal.	Low income references removed from market description in the TRM measure sections
6	NJ Utilities Association (NJUA)	2.1.2	25	Residential	Appliances	Clothes Dryer	References List	Numbering starts with [11] instead of [1] (continuing from previous section). They don't restart at [1] until section 3.5.11 and again in 3.12.2	Fixed instances where numbering restarts for consistency
7	NJ Utilities Association (NJUA)	2.1.4	31	Residential	Appliances	Induction Range/Cooktop	Multifamily missing	Several measures that would be applicable to MF are missing MF in the Market box. Should scrub draft TRM to confirm that all measures applicable to MF have MF noted.	MF applicability has been checked and updated.
8	NJ Utilities Association (NJUA)	2.1.4	32	Residential	Appliances	Induction Range/Cooktop	Table 2-17 'F_elec,b' and 'F_fuel,b'	Need non-zero defaults for POS rebates	Non-zero defaults for POS rebates provided.
9	NJ Utilities Association (NJUA)	2.1.4	33	Residential	Appliances	Induction Range/Cooktop	Induction Range/Cooktop: measure life	EUL of 16 years for induction ranges could not be located in the reference [29]. Reference should be updated to V10 which includes EUL.	Corrected
10	NJ Utilities Association (NJUA)	2.1.5	34	Residential	Appliances	Refrigerators	NR replaced with TOS	This one example where NR still remains in the detailed measures and should be TOS.	Corrected
11	NJ Utilities Association (NJUA)	2.1.6	42	Residential	Appliances	Freezer	Table 2-25 'kWh_ex'	Need 'kWh_ex' similar to 'Refrigerators' section 2.1.5	Updated lifetime section language
12	NJ Utilities Association (NJUA)	2.1.6	42	Residential	Appliances	Freezer	Freezer: table 2-25	Need reference for the HVACc and HVACd values? MA/MMD TRM does not account for interaction effects.	Added reference: NY TRM v10
13	NJ Utilities Association (NJUA)	2.1.6	42	Residential	Appliances	Freezer	Table 2-26 caption	Typo in Table Title. "Efficienct" should be "Efficient"	Corrected
14	NJ Utilities Association (NJUA)	2.1.6	44	Residential	Appliances	Freezer	Table 2-28 'F_occ'	Need "Unknown" rather than 0 in the row where 'F_occ' = 1.00	Corrected
15	NJ Utilities Association (NJUA)	2.1.8	50	Residential	Appliances	Air Purifier	Air Purifier: table 2-34	Life therms savings are not applicable and can be removed from this table to be consistent with other measure's format.	Removed
16	NJ Utilities Association (NJUA)	2.1.8	50	Residential	Appliances	Air Purifier	Table 2-34 'Description' field	Typo in 'Description' of 'PartialPower_b' and 'PartialPower_q'. "Partial On **Model** Power" should be "Partial On **Mode** Power".	Corrected
17	NJ Utilities Association (NJUA)	2.1.8	51	Residential	Appliances	Air Purifier	Tables 2-35 and 2-36 CADR Range	The smallest Range should include 30cfm to match Energy Star (30 ≤ CADR < 100). Range endpoints should match between rows (the "less than" and "greater than or equal to" signs take care of the overlap.	Corrected

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18	NJ Utilities Association (NJUA)	2.1.10	57	Residential	Appliances	Room Air Conditioner	Room Air Conditioner: Measure description	Remove heat pump and heating verbiage if heating savings are not accounted (or add heating savings for reverse cycle units). The second paragraph describes a 5% CEER allowance for units that can be networked. It says "In these instances, the default efficient CEER would be 0.95 multiplied. It should be the base CEER that is discounted by 5%. For CEER (of the new ee measure) = use site specific (remove default option as the CEER and capacity of the new unit will be known)	Removed heat pump language, but left heating language. If we remove heating language, it may imply that units that are able to provide cooling and heating are not eligible. They should be eligible even if heating savings are not accounted for. Agree with the comment regarding 5% CEER allowance. Updated language so that 0.95 is applied to baseline CEER instead of efficient CEER
19	NJ Utilities Association (NJUA)	2.2.3	68	Residential	Appliance Recycling	Dehumidifier Recycling	Table 2-55	Need guidance when 'Manufacture Date' is unknown due to illegible nameplate.	Added "If equipment vintage is unknown, assume 2/3 EUL."
20	NJ Utilities Association (NJUA)	2.3.1	70	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	CAC,ASHP, Mini-Splits, PTAC, PTHP description	Minor typos in description and baseline case paragraph ("muli-family" "Comercial" missing period end of 2nd paragraph)	Corrected
21	NJ Utilities Association (NJUA)	2.3.1	70	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Central AC, ASHP, Mini-Splits, PTAC, PTHP: Typo	Correct typo in description (last sentence of first paragraph) low--rise.	Corrected
22	NJ Utilities Association (NJUA)	2.3.1	71	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-57 Baseline Energy Consumption	Correct typo in Mini-split heat pump, ASHP (cooling capacity < 65 kbtu/hr) baseline cooling equation. Cap should be Cap_c	Corrected
23	NJ Utilities Association (NJUA)	2.3.1	71	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Central AC, ASHP, Mini-Splits, PTAC, PTHP: OSF	Prior comments address that the savings algorithms indicate the OSF is to be used in all cases, however would likely only apply to certain HP applications. The footnotes explain this, however can foresee how this can be overlooked and cause confusion. Possibly clarify with note in the text prior to table 2-57 that OSF applies to HP.	Added the following note: The oversize derating factor (OSF) in the equations above is typically applicable for certain heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. A user with a better understanding of site specific conditions can determine whether this factor is applicable or not.
24	NJ Utilities Association (NJUA)	2.3.1	71	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-57	SEER, EER, HSPF should be SEER2, EER2, HSPF2	EER to EER2 conversion table provided in Appendix. Added a note saying use EER2/SEER2,IEER2 if available the way we did it in "Heat or Energy Recovery Ventilator"
25	NJ Utilities Association (NJUA)	2.3.1	72	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	ΔkWhEX and ΔkWhNR	ΔkWhEX and ΔkWhNR are not defined in this measure	Updated lifetime section language
26	NJ Utilities Association (NJUA)	2.3.1	72	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	ΔthermsNR and ΔthermsNR	ΔthermsEx and ΔthermsNR are not defined in this measure	Updated lifetime section language
27	NJ Utilities Association (NJUA)	2.3.1	73	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-60 OSF	Please add OSF = 1.0 for Central AC since they're not sized on heating.	Updated
28	NJ Utilities Association (NJUA)	2.3.1	73	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-60	Algorithms and variables should be for SEER2, EER2, HSPF2, etc. Formulas should be provided to convert from SEER to SEER2, if necessary (working in conjunction with Appendix E).	EER to EER2 conversion table provided in appendix Added a note saying use EER2/SEER2,IEER2 if available the way we did it in "Heat or Energy Recovery Ventilator"
29	NJ Utilities Association (NJUA)	2.3.1	73	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	SEER_b	Appendix E is missing the EER to EER2 conversion. This is needed for the utilities to calculated the kW demand savings.	EER2 to EER conversion guidance added to Appendix E.
30	NJ Utilities Association (NJUA)	2.3.1	75	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-60 CF ref	Value' field points to Table 3-132 instead of Table 2-61	Corrected
31	NJ Utilities Association (NJUA)	2.3.1	75	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Central AC, ASHP, Mini-Splits, PTAC, PTHP: References	References cited in measure can be cleaned up to reflect the list at the end of the measure. Several references are cited and not shown in the list following the measure.	Corrected
32	NJ Utilities Association (NJUA)	2.3.2	77	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Heat Pumps	Based on the baseline description, there is no TOS scenario for heat pump - all heat pumps, except for new construction, are fuel-switching. Is that the intent or expectation? i.e. this creates confusion for any midstream prescriptive-type heat pump measure. Consider separating measures so that the baselines can be clearly addressed for the various common scenarios, which are varied and complicated.	Added the phrase 'Time of Sale' in the first paragraph. With this phrase, the measure is laid out to allow for many combinations of baseline/proposed equipment. Note: Heat Pumps will receive a closer look in the upcoming study
33	NJ Utilities Association (NJUA)	2.3.2	78	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-64, Eff Circ Pump kWh	Add an ESF if VFD are present as most efficient GSHP typically have variable flow water loops, per commercial measure.	Added

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34	NJ Utilities Association (NJUA)	2.3.2	78	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-63, Eff b	Eff b value in baseline circ pump kWh equation is stated as Eff motor b throughout the measure.	Changed to Eff,motor,b
35	NJ Utilities Association (NJUA)	2.3.2	79	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Annual Fuel Savings, Therms b	See Table 2-65, not 3-106.	Corrected
36	NJ Utilities Association (NJUA)	2.3.2	79	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Peak Demand Savings	Add a DSF if VFD are present as most efficient GSHP typically have variable flow water loops, per commercial measure.	Added
37	NJ Utilities Association (NJUA)	2.3.2	79	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Peak Demand Savings	Adding to above comment, there should be an additional peak kW equation for the circ pump - per C&I measure.	Added
38	NJ Utilities Association (NJUA)	2.3.2	81	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-66, Eff motor b	Look up value in Table 2-67, not 3-108.	Corrected
39	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-66, Therms b	Therms b value can be looked up in table 2-65, not 3-106.	Corrected
40	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-66,CFs and PDF	CF c, CF pump, and PDF should reference table 2-68, not 3-132.	Corrected
41	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-63, Hrs	Appendix D is referenced to look up operating hours of pump motor. Appendix D is for C&I, and Res/MF pump operating hours are not listed. C&I measure states to add EFLH c+h, perhaps same thing here?	Guidance on residential motor run hours provided.
42	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-63, EFLH c	Seems to have wrong source cited.	NY TRM uses same hours for air source and ground source, changed hours to Appendix C: Heating and Cooling EFLH
43	NJ Utilities Association (NJUA)	2.3.2	83	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-68	Add CF pump value and cite source.	Added
44	NJ Utilities Association (NJUA)	2.3.2	83	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: References	Reference 86 not cited in measure but present in list. General comment to clean up references throughout measure to reflect list.	Corrected
45	NJ Utilities Association (NJUA)	2.3.5	93	Residential	HVAC	EC Motor	EC Motor: Table 2-78	Annual Energy Savings Per Fan Motor should not point to reference [108]. Perhaps this reference was meant for a different line?	Updated reference and included a note that the given energy savings were calculated by scaling savings from a study
46	NJ Utilities Association (NJUA)	2.3.5	93	Residential	HVAC	EC Motor	EC Motor: Table 2-78	For dkWh_fan, value in reference [109] Is 0.117. Clarify if some kind of scaling is in place?	Appears to be a typo. The value we originally had listed in TRM is 0.117, while the reference lists 0.116. Updated value in parameters table to 0.116 to match reference
47	NJ Utilities Association (NJUA)	2.3.5	93	Residential	HVAC	EC Motor	EC Motor: Table 2-78	LF and hrs_c should also reference [112], the NY trm	Corrected
48	NJ Utilities Association (NJUA)	2.3.5	94	Residential	HVAC	EC Motor	EC Motor: References	The NY TRM link does not work.	Corrected
49	NJ Utilities Association (NJUA)	2.3.6	96	Residential	HVAC	Duct Sealing and Duct Insulation	Duct Sealing and Duct Insulation: Dual Baseline	Dual baseline is either not applicable and this should be updated to reflect that the existing condition is baseline, or... the difference between EREP and NR need to be addressed. Terms are not defined in Table 2-82.	Removed dual baseline, updated baseline description language
50	NJ Utilities Association (NJUA)	2.3.7	101	Residential	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : References	For ASHRAE and IECC referenced, include section number and page number in text	Corrected
51	NJ Utilities Association (NJUA)	2.3.7	102	Residential	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Annual Fuel Savings	60 factor in therms savings algorithm is incorrect, needs to be removed.	Corrected
52	NJ Utilities Association (NJUA)	2.3.8	112	Residential	HVAC	Maintenance	Table 2-98	Measure life is missing for DMSHP and DMSAC units	Added
53	NJ Utilities Association (NJUA)	2.3.9	114	Residential	HVAC	Boiler Controls	Boiler Controls: Table 2-99, EFLH h	Look up in table 2-100, not 3-120.	Corrected
54	NJ Utilities Association (NJUA)	2.3.9	115	Residential	HVAC	Boiler Controls	Boiler Controls: References	Reference numbers stated in measure do not match list.	Corrected
55	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, Cap c	Reference needed for cooling capacity assumptions.	Corrected
56	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, SEER	If SEER unknown, should look up in Appendix E, not Appendix C	Corrected
57	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, F elec cool	How was the unknown value of 39% derived? The cited source does not explicitly state this value and it is unclear how it was derived.	Source clarified
58	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Take 2-110, Cap h out	Reference needed for output heating capacity assumptions.	Source clarified

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59	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Cap C (units not in tons)	Cap c should not be in tons, it should be in kBtuh	Corrected
60	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, EFLH H	Text in value column should be consistent with language in EFLH C value column.	Corrected
61	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Table 2-110	Efficiency values in table 2-110refer to Appendix C, but Appendix C deals with EFLH estimates.	Corrected
62	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, AFUE	Reference needed for unknown values.	Reference provided
63	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, F elec heat	How was the unknown value of 15% derived? The cited source does not explicitly state this value and it is unclear how it was derived.	Source clarified
64	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, F fuel heat	How was the unknown value of 91% derived? The cited source does not explicitly state this value and it is unclear how it was derived.	Source clarified
65	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-111	Source needed for Appendix G PDF values.	PDF linked to Appendix
66	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Measure Life	Suggest adding a table consistent with other measures. As the host equipment RUL is referenced, suggest adding those values in the table as well.	Updated
67	NJ Utilities Association (NJUA)	2.4.1	133	Residential	Lighting	Lamps and Fixtures	Table 2-112 Calculation Parameters	Wattage of Baseline Fixture value - A bit confusing, is the exempt tables only applied to DI channel? Maybe reorganize to make it clear, also add language later before the exempt tables to avoid confusions.	It looks like adding the word 'Direct Install' makes it confusing so I removed it. Based on the description in the 'Baseline Section', EISA Exempt: site specific or lookup in table EISA Compliant: calculate using the 45 lumens/watt It doesn't really matter whether its DI or not because lights installed through that channel are also subject to EISA Complaince
68	NJ Utilities Association (NJUA)	2.4.1	133	Residential	Lighting	Lamps and Fixtures	Table 2-112	Please add a row for the 0.03412 factor and indicate it has units of 'Therms/kWh'	Added
69	NJ Utilities Association (NJUA)	2.4.1	137	Residential	Lighting	Lamps and Fixtures	Table 2-115 typo	Typo "ecorative" should be "Decorative"	Corrected
70	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	provide source for the assumed wattage (if unknown) of Wq.	Added source
71	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	provide source for the assumed percentage (if unknown) of SVGd	Removed SVGd because its the same as SVGe; changed value from 49 to 28 because the 2 sources average is 28, not 49
72	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	change unknown value of SVGd to 49 and indicate units as %, provide reference	Change has been implemented
73	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	change unknown value of SVGe to 49 and indicate units as %	Change has been implemented
74	NJ Utilities Association (NJUA)	2.5.1	147	Residential	Plug Load	Office Equipment	Office Equipment: Table 2-126	The "Source" for each of the office equipment values is "1", it seems this should be "[185]"	Corrected
75	NJ Utilities Association (NJUA)	2.5.1	147	Residential	Plug Load	Office Equipment	Office Equipment: Table 2-126	Laser color options have not been included in any of the office equipment categories. This option has more savings associated with it and should be considered as a part of the TRM for printers and multi-function devices.	Conducted a due-diligence sweep: NY TRM: Nothing there Mid Atlantic TRM: Same approach as ours PA TRM: Same approach as ours CT PSD: Also relies on Energy Star IL TRM: Nothing helpful Available studies are pretty old: 1992, 1996, 1997, 2004 To conclude, we propose stick to the current methodology until a better source for algorithms with different laser colors can be identified.
76	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment: Table 2-126	Default energy savings for "Monitor" in the calculation tool is 8 kWh, the TRM provides 24 kWh as the deemed savings value.	Changed to 8
77	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment:	The commercial office equipment measure includes the proper link to the ENERGY STAR Office Equipment Calculator. There is an option within the calculator for "Residential." Please include that calculator link in reference [185] of this measure.	Updated
78	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment:	Reference [186] links to Energy Star Computers V8.0, but is not used in the Residential Office Equipment measure. This reference is probably intended to be sited within reference [185] and/or Table 2-126	Updated
79	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment:	Reference [187] hyperlink does not work properly. "Website Not Found"	Updated

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80	NJ Utilities Association (NJUA)	2.5.3	154	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-131	ΔkWhEREP and ΔkWhNR are used to define ΔkWhLife, but are not defined in Table 2-131	Updated lifetime section language
81	NJ Utilities Association (NJUA)	2.5.3	155	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-131	Table 2-131 lists the value of ISR as "Link to ISR appendix." However there are explicit ISR values in Table 2-132 from the MA study reference [191]. Are the values in the appendix different from the reference study? There should only have ISR in one location to avoid confusion and values not aligning down the road. Review ISR for Home Entertainment and Unspecified to 0.76 and 0.81 based on ISR+RET column in Table 16 of Ref 191, if that is the reference in ISR table.	Corrected
82	NJ Utilities Association (NJUA)	2.5.3	155	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-132	Savings for "Tier 2 - Home Entertainment Center" aligns with savings values for "Tier 2 - All" in the referenced report. Consider changing the "Tier 2 End-Use" to "Unspecified" like it is in Tier 1.	Corrected
83	NJ Utilities Association (NJUA)	2.5.3	155	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-132	Deemed demand savings values (kW) do not align with reference [191] Table 1 values. Consider revising to match the referenced table.	Updated
84	NJ Utilities Association (NJUA)	2.5.3	156	Residential	Plug Load	Smart Strip	Smart Strips:	Reference [191] hyperlink does not work properly. "404 cannot be found"	Corrected
85	NJ Utilities Association (NJUA)	2.5.4	158	Residential	Plug Load	SoundBar	Soundbar: Reference	Reference [193] hyperlinks to an Energy Star website rather than the PDF written in the reference. Change the hyperlink to direct to the PDF.	Unable to find version 2 of this paper to reference. Unable to find 7 year EUL in future editions
86	NJ Utilities Association (NJUA)	2.5.4	158	Residential	Plug Load	SoundBar	Soundbar: Baseline	Table 2-135 indicates 77 kWh/year soundbar baseline energy consumption referenced in [193]. There is no indication in this reference of baseline soundbar energy consumption.	Tracked down a workpaper with base case of 82 kwh/yr and post case of 29 kwh/yr, changed the reference
87	NJ Utilities Association (NJUA)	2.5.4	159	Residential	Plug Load	SoundBar	Soundbar: Reference	Reference [195] "Per NY TRM: "No source specified – update pending availability and review of applicable references." How does the TRM arrive a CF of 0.8 without this reference?	The NY TRM uses 0.8 as a blanket assumption when CF is unknwown. We are using the NY TRM for this measure because a better alternative is not available at this point.
88	NJ Utilities Association (NJUA)	2.5.5	160	Residential	Plug Load	Electric Vehicle Chargers	Annual Electric Energy Savings Equation	Second term in equation is (Hrs_PS * W_q,p * Hrs_US * W_q,u,) Should be (Hrs_PS * W_q,p + Hrs_US * W_q,u,)	Corrected
89	NJ Utilities Association (NJUA)	2.6.1	163	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-Rise Multifamily Air Sealing Description	The measure focuses on the inclusion of a blower door test. For clarity, either include a separate method for no blower door test, or move footnote 39 which provide default value in the main body and/or in the calculation parameter table	The reason why CFM50 = 0.50 x SF is not in the main body is to make sure the user defaults to using the blower door test to come up with CFM50 instead of directly calculating using this equation. In the parameter table, I replaced the word 'Calculated' with the equation itself and left the footnote as is to provide clarification to the user
90	NJ Utilities Association (NJUA)	2.6.1	164	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-Rise Multifamily Air Sealing Annual Energy Savings Algorithm	The NYS TRM v10 Air Leakage Sealing measure formula might be a better way to present the calculation	High-rise multifamily is not included for residential measures. The algorithms included in this measure are exclusively for low-rise multifamily or without blower door test. The algorithm which is presented in the NY TRM is used exclusively for high-rise multifamily
91	NJ Utilities Association (NJUA)	2.6.1	165	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-rise Multifamily Air Sealing: table 2-142	Provide source for deemed savings values in table 2-142. Reference link indicates values are based on NY TRM v10, but the values in NY TRM v10 are specific to city locations in NY state.	The source is NY TRM. We used NYC values because of the cities in the NY TRM, NYC is the closest to a statewide NJ approximation. Added a line in the reference to explain this.
92	NJ Utilities Association (NJUA)	2.6.1	166	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-rise Multifamily Air Sealing: table 2-143	Provide source for deemed savings values in table 2-143. Reference link indicates values are based on NY TRM v10, but the values in NY TRM v10 are specific to city locations in NY state.	The source is NY TRM. We used NYC values because of the cities in the NY TRM, NYC is the closest to a statewide NJ approximation. Added a line in the reference to explain this.
93	NJ Utilities Association (NJUA)	2.7.1	175	Residential	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: table 2-155	Include values 3.41 and 3.34 from peak demand savings equation and provide source in references section.	Updated
94	NJ Utilities Association (NJUA)	2.7.1	175	Residential	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: table 2-155	Value for variable Nppl indicates a GPM value for people. Recommend revising as "2.62" if unknown.	Updated
95	NJ Utilities Association (NJUA)	2.7.3	185	Residential	Water Heating	Storage Tank Water Heater	Storage Water Heater: table 2-167	Value for variable Nppl indicates a GPM value for people. Recommend revising as "2.62" if unknown.	Updated
96	NJ Utilities Association (NJUA)	2.7.6	198	Residential	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators: annual fuel savings formula	include a term (Fgas) in the dTherms calculation to account for the water heater fuel type. Fgas= Fraction of water heaters which are gas = 0.71 Source: From 2015 RECS microdata for Middle Atlantic Div 8. Of 228 households, fuel mix for water heating is 71% gas and 25% electric. No savings are attributed to 4% of households which use other fuel sources.	Updated
97	NJ Utilities Association (NJUA)	2.7.6	199	Residential	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators: table 2-176	correct typo in value for variable Fgas. Update from unkown to unknown.	Corrected

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98	NJ Utilities Association (NJUA)	2.8.2	220	Residential	Whole Building	HPwES	kW savings for HPwES	Many of the approved software tools do not generate hourly outputs, particularly REM/Rate and Snugg Pro, which are popular in this field. This comment requests a simple guidance or algorithm on how to calculate peak demand impacts from these files or acceptance of the method the utilities are using in Tri1. The program is expected to make a very small contribution to total portfolio-wide demand reductions for any utility, so an approximation such as kW to kWh ratios for gas heated vs electricity heated homes or something similar seems appropriate. The utilities agreed for the first Triennium to calc kW by applying an average factor of 0.0006033 kW to kWh saved based on analysis of residential load shapes for non-electric heated homes from May-Sept. The methodology for obtaining this ratio and the final NJ average value programmed into SnuggPro was vetted through our evaluators.	Peak demand algorithms for whole building projects added based on comment.
99	NJ Utilities Association (NJUA)	3	223	C&I	C&I	C&I	Additional C/I Measures for consideration	Consider including additional C&I measures: Elevator Modernization measure (see NY trmv10) Fan destratification (see Illinois TRM) Steam trap repair/replace Future kits may include can of spray foam. Could this (e.g. 12-oz can of spray foam) be addressed in air sealing section, or as stand-alone measure?	*Steam traps - measure added using NY TRM approach with ERS defaults *Elevator & fan destrat - measure added based on NY TRM approach *Spray foam - added to air sealing section
100	NJ Utilities Association (NJUA)	3.1.2-3.1.4	Multiple	C&I	Agriculture	Multiple	Calculation parameters	Different values used for specific heat of milk throughout. Consider revising for consistency	Used 0.93 and updated references
101	NJ Utilities Association (NJUA)	3.1.1	223	C&I	Agriculture	Auto Milker Takeoff	Auto Milker Takeoff: Footnote Sources	Please update reference sources under footnote 60 to match the reference list for this measure.	Corrected
102	NJ Utilities Association (NJUA)	3.1.1	223	C&I	Agriculture	Auto Milker Takeoff	Auto Milker Takeoff:	Could not view V1.2, only V1.1, where it was not clear where the kW/kWh value is derived.	V1.2 accessed using link provided in the TRM. ETDF derived by dividing the retail demand savings (kW) by electric energy savings (kWh)
103	NJ Utilities Association (NJUA)	3.1.5	238	C&I	Agriculture	Livestock Waterer	Table 3-13	Multiple references to table 3-15 should be 3-14. This was a recurring issue in the initial TRM review (often misplaced table references to Peak Factor tables). Consider a review of table references in Calculation Parameters tables.	Corrected
104	NJ Utilities Association (NJUA)	3.1.7	245	C&I	Agriculture	Ventilation Fans	Ventilation Fans:	Multiple issues with dual baseline. There's no approach to estimate kWherep vs kWhnr. Lifetime equation should have EUL - RUL	Updated lifetime section language
105	NJ Utilities Association (NJUA)	3.1.7	247	C&I	Agriculture	Ventilation Fans	Ventilation Fans:	Edit Footnote (ref 66) 'temperature above 50⁰F	Corrected
106	NJ Utilities Association (NJUA)	3.1.9	256	C&I	Agriculture	Engine Block Heater Timer	Engine Block Heater Timer: W heater, Hrs b, Hrs q, Days, UF	All values citing source 345 originate from a 2015 Wisconsin study with 27 responses. Is it applicable to use an 8yr old study with limited participation for weather-correlated usage values? NYS TRM has similar calculation method with different usage values referencing "Energy Efficiency in New York State Agriculture: Summary of Energy Efficiency Programs and Research Opportunities, NYSERDA, C-4:. Might be worth exploring.	I agree. Changed the values and updated the reference
107	NJ Utilities Association (NJUA)	3.2.1	261	C&I	Appliances	Clothes Washer	Table 3-34	Need an unknown SF for DHW fuel type and Dryer fuel type	DHW fuel type link to appendix, dryer fuel split provided
108	NJ Utilities Association (NJUA)	3.3.2	295	C&I	Appliance Recycling	Room AC Unit Recycling	Room AC Unit Recycling: Calculation Methodology	The calculation methodology was supposed to be updated for this measure, as the Residential measure was, per the IMP for EmPOWER MD.	Updated measure per IMP for EmPOWER MD
109	NJ Utilities Association (NJUA)	3.3.2	295	C&I	Appliance Recycling	Room AC Unit Recycling	Room Air Conditioner: Lifetime Energy Savings Algorithms and Table 3-74	Use Remaining useful life not EUL for Recycling lifetime savings	Updated measure per IMP for EmPOWER MD
110	NJ Utilities Association (NJUA)	3.3.2	296	C&I	Appliance Recycling	Room AC Unit Recycling	Room AC Unit Recycling: Table 3-74, EFLH C	No value stated for EFLH C.	Updated measure per IMP for EmPOWER MD
111	NJ Utilities Association (NJUA)	3.3.2	296	C&I	Appliance Recycling	Room AC Unit Recycling	F_replaced	This value should be based on program design and only if the program induces the replacement. F_replaced = 0 for recycled units picked up from businesses without replacements provided at the same time. The 'Description' refers to a "home". The 'Baseline Condition' is "ERET", meaning the existing equipment is not replaced.	Updated measure per IMP for EmPOWER MD
112	NJ Utilities Association (NJUA)	3.3.2	296	C&I	Appliance Recycling	Room AC Unit Recycling	EFLHc	'Value' field is blank. Is it based on Building Type?	Updated measure per IMP for EmPOWER MD
113	NJ Utilities Association (NJUA)	3.3.3	298	C&I	Appliance Recycling	Dehumidifier Recycling	Dehumidifier Recycling: Table 3-76, Capacity	Provide reference for capacity assumption.	Added reference: Mid-Atlantic TRM

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114	NJ Utilities Association (NJUA)	3.3.3	300	C&I	Appliance Recycling	Dehumidifier Recycling	Dehumidifier Recycling: CF	Update reference number. [372] in table 3-78 on page 300, [372] is not a reference for this section.	Corrected
115	NJ Utilities Association (NJUA)	3.3.3	300	C&I	Appliance Recycling	Dehumidifier Recycling	Table 3-78 Ref	Ref 372 should be 395	Corrected
116	NJ Utilities Association (NJUA)	3.4.2	312	C&I	Foodservice	Holding Cabinets	Holding Cabinets: Table 3-86, Days/year	Appendix D does not explicitly state operating days per year. Should give guidance to calculate or provide values in a table in the measure.	Updated
117	NJ Utilities Association (NJUA)	3.4.2	312	C&I	Foodservice	Holding Cabinets	Holding Cabinets: Table 3-86, Days/year	NJ CEP FY2020 references a table for Hours & Days per building type referencing source 419. Would this be more appropriate? NYS TRM also utilizes a table referencing a report by the California Energy Commission.	Operating days in appendix D are based on the NJ building prototypes. Suggest staying with those values in the interest of consistency with EFLH, etc.
118	NJ Utilities Association (NJUA)	3.4.2	313	C&I	Foodservice	Holding Cabinets	Holding Cabinets: Description	Update full size holding cabinet cubic ft to >/= 13 < 28, per table 3-87, so it aligns with the language in the description section	Corrected
119	NJ Utilities Association (NJUA)	3.4.3	314	C&I	Foodservice	Dishwashers	Dishwashers Annual Electric Savings Algorithm	The Delta_kWh_boosterheater formula is the same as Delta_kWh_waterheater formula? Should be different	Updated
120	NJ Utilities Association (NJUA)	3.4.3	317	C&I	Foodservice	Dishwashers	Dishwasher: Table 3-92, PDF	define PDF value	Corrected
121	NJ Utilities Association (NJUA)	3.4.4	319	C&I	Foodservice	Ice Machines	Ice Machines: Baseline Condition	Prior drafts of this measure had this measure as NR, which has been replaced with DI. Revised measure needs dual baseline for DI. Description should reflect both DI and TOS conditions.	Updated
122	NJ Utilities Association (NJUA)	3.5.1	325	C&I	HVAC	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP: Annual Fuel Savings, Therms b	See Table 3-100, not 3-106.	Corrected
123	NJ Utilities Association (NJUA)	3.5.2	326	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Typo	Pumpsin should be changed to pumps in, found in first sentence under description section.	Corrected
124	NJ Utilities Association (NJUA)	3.5.1	327	C&I	HVAC	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP: OSF	Prior comments address that the savings algorithms indicate the OSF is to be used in all cases, however would likely only apply to certain HP applications. The footnotes explain this, however can foresee how this can be overlooked and cause confusion.	Added the following note: The oversize derating factor (OSF) in the equations above is typically applicable for certain heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. A user with a better understanding of site specific conditions can determine whether this factor is applicable or not.
125	NJ Utilities Association (NJUA)	3.5.2	333	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Table 3-104, Baseline Circ Pump	Eff b should be changed to Eff motor b as referred to in 3-107 Calculation Parameters.	Change has been implemented
126	NJ Utilities Association (NJUA)	3.5.2	333	C&I	HVAC	Geothermal and Water Source Heat Pumps	Table 3-107 Calculation Parameter - Update Appendix Link	Update value for "Hrs" - says "Look Up in X"	Corrected
127	NJ Utilities Association (NJUA)	3.5.2	333	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Table 3-107, Hrs	Update look up to correct Appendix, cite source.	Corrected
128	NJ Utilities Association (NJUA)	3.5.2	335	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: ESF/DSF Reference	No source provided for values. Found the values reference the current NJ TRM for VFD 3.7.8, which cites the IL TRM V7 and link provided does not provide access. Could not find mention of values in the IL TRM V7. Please find additional link to source and explicitly state where values can be found.	Values calculated using methodology and parameters laid out in measure - will check math Also double check ESF, DSF in Residential measure
129	NJ Utilities Association (NJUA)	3.5.2	336	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Table 3-109, PDF	Update from TBD to Appendix G.	Corrected
130	NJ Utilities Association (NJUA)	3.5.4	336	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Efficient Case Description - Typo	Equipment misspelled	Corrected
131	NJ Utilities Association (NJUA)	3.5.4	336	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Annual Energy Savings Algorithm	Missing kWhq formula?	Meausure is for gas furnaces, unit heaters, and boilers, so no kWh consumption in efficient case. Measure states kWhq = 0.
132	NJ Utilities Association (NJUA)	3.5.3	339	C&I	HVAC	Infrared Heater	Infrared Heater: Table 3-111, HDD55	No reference provided for HDD 55, likely #450 per HDD 65.	Corrected
133	NJ Utilities Association (NJUA)	3.5.3	339	C&I	HVAC	Infrared Heater	Infrared Heater: Table 3-111, EFLH h	No value present or link to table/Appendix for EFLH h.	Corrected
134	NJ Utilities Association (NJUA)	3.5.3	339	C&I	HVAC	Infrared Heater	Infrared Heater: Table 3-111, PDF	PDF not listed in calc parameters table as seen in other measures.	Corrected
135	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Appendix "X"	Baseline efficiency found in Appendix E.	Linked to correct appendix
136	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Typo	Change equipmentif to equipment if in first bullet point explaining dual baselines for early replacement.	Corrected

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137	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: EREP Dual Baselines	Second bullet point - baseline is a code-complaint air source heat pump?	Corrected to "code-compliant unit of same type and size as the installed equipment"
138	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Baseline Efficiencies	Baseline efficiencies match 90.1-2019, except for 2 instances (Steam boiler, gas fired <300 & steam boiler oil fired <300). I believe this is because per 90.1-2019 table 6.8.1-6, those values are only applicable outside US. In that case, what source was used for the values stated in place? Please cite separately if another source was used.	In 90.1 2019, there's a footnote saying "See Informative Appendix F, Table F-4, for U.S. minimum efficiencies for residential products covered by USDOE requirements for U.S. applications" which is what was used for this measure. So essentially the source is the same
139	NJ Utilities Association (NJUA)	3.5.4	343	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Capacity variables	Cap h shown in the algorithms, but Table 4-115 only lists Cap in.	Changed from Cap,h to Cap,in
140	NJ Utilities Association (NJUA)	3.5.4	344	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Table 3-115, EFLH h	No value present or link to table/Appendix for EFLH h.	Corrected
141	NJ Utilities Association (NJUA)	3.5.5	347	C&I	HVAC	Boiler Controls	Boiler Controls: SF - Cut-Out Controls	Many prior comments regarding this savings factor. Restating that Arkansas TRM specifically states a value of 1.7%, however is used as the source for the 2.2% value, which was scaled per the study referenced. Also the TRM version cited is outdated and was able to track a path for the latest version (https://apsc.arkansas.gov/wp-content/uploads/AR_TRM_V9.1_Volume_1_2_and_3_on_8-31-22.pdf).	Updated number to 1.7 and updated reference
142	NJ Utilities Association (NJUA)	3.5.7	355	C&I	HVAC	Gas Chillers	Gas Chillers: Table 3-127, Cap	There are two variables listed as the same "Cap" with different descriptions and values.	Deleted extra 'Cap' parameter
143	NJ Utilities Association (NJUA)	3.5.7	355	C&I	HVAC	Gas Chillers	Gas Chillers: References	This document needs references for COP b (mentioned above), EFLH, PDF, and measure life variables. Only one reference stated which is vague and not linked to any variable.	EFLH, PDF: found in appendix (methodology/reference explained in appendix) COPb: added reference
144	NJ Utilities Association (NJUA)	3.5.7	355	C&I	HVAC	Gas Chillers	Gas Chillers: References	There is no reference cited for ASHRAE 90.1-2019, used for table 3-128 minimum efficiencies referencing 90.1-2019 6.8.1-3.	Added reference
145	NJ Utilities Association (NJUA)	3.5.8	357	C&I	HVAC	Electric Chillers	Electric Chillers: Table 3-130, EFLH	Table states look up EFLH values in Appendix F, however EFLH are stated in Appendix C.	Corrected
146	NJ Utilities Association (NJUA)	3.5.10	371	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Table 3-149 Calculation Parameters	hrs_h - Delete [125] - duplicate reference not needed.	Corrected
147	NJ Utilities Association (NJUA)	3.5.10	376	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Table 3-154 Peak Factors	Natural gas PDF is not N/A for this measure.	Corrected
148	NJ Utilities Association (NJUA)	3.5.10	376	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Table 3-154 Peak Factors	[123] appears to be incorrect reference.	Updated
149	NJ Utilities Association (NJUA)	3.5.10	376	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Measure Life	[124] appears to be incorrect reference.	Updated
150	NJ Utilities Association (NJUA)	3.5.13	385	C&I	HVAC	EC Motor	Demand Controlled Kitchen Ventilation: PLR Value Reference	PLR values in table 3-162 need a reference source.	It's the Mid Atlantic TRM for both. Added reference
151	NJ Utilities Association (NJUA)	3.5.13	386	C&I	HVAC	EC Motor	Demand Controlled Kitchen Ventilation: References	Table 3-164 needs reference sources.	It's the Mid Atlantic TRM for both. Added reference
152	NJ Utilities Association (NJUA)	3.5.15	397	C&I	HVAC	Guest Room EMS	Guest Room EMS: Measure Life	Should EUL values of common HVAC equipment be presented in the Measure Life section, to be consistent with other measures in the document?	Updated
153	NJ Utilities Association (NJUA)	3.5.16	397	C&I	HVAC	Smart Thermostat	Guest Room EMS: References	Table 3-173 needs reference sources.	Source provided
154	NJ Utilities Association (NJUA)	3.5.17	399	C&I	HVAC	Maintenance	Smart Tstats: SEER/IEER	Has further thought been applied to prior comment: "ADM: Adding "or IEER" seems warranted?JCP&L Vendor: Since eligibility for this measure is up to 25 tons, suggest adding calculation that incorporates IEER for units above 5.4 tons. Current calculation only utilizes SEER, which only applies to units <5.4 tons"	Yes, will update to allow for use of IEER
155	NJ Utilities Association (NJUA)	3.5.16	401	C&I	HVAC	Smart Thermostat	Smart Tstats: Measure Life	Suggest adding a table consistent with other measure. As the host equipment RUL is reference for RF scenarios, suggest adding those values in the table as well.	Updated
156	NJ Utilities Association (NJUA)	3.5.18	409	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Controls: Table 3-180 (Row 7-8)	Reference is inadequate. Calculations for Energy savings factors (SF_ElecCool and SF_ElecHeat) for locations mentioned in TRM are not listed.	Updated
157	NJ Utilities Association (NJUA)	3.5.18	411	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Control: Table 3-181	Space types in Table 3-181 should be updated to match the other tables in this section (e.g. Table 3-182). Also, is 'multi-family exterior' a relevant space type for this measure? Maybe intended to be some kind of parking garage ventilation?	Updated
158	NJ Utilities Association (NJUA)	3.5.18	414	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Control: Table 3-186	Space types in Table 3-186 should be updated to match the other tables in this section (e.g. Table 3-182).	Updated

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159	NJ Utilities Association (NJUA)	3.5.18	414	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Control: Table 3-187	PDF reference should be updated from 'TBD'	Corrected
160	NJ Utilities Association (NJUA)	3.6.1	417	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: Blower door tests	Blower door tests results are not used in energy savings algorithms. Remove text: "Blower door tests shall be performed whenever possible. A blower door test is performed to measure the leakage rate by depressurizing the building to a standard pressure difference of 50 Pascals or 0.2 inches of water. The measured flowrate indicates the leakage rate, or infiltration and exfiltration rate, of the building shell".	Updated
161	NJ Utilities Association (NJUA)	3.6.1	417	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: Home square feet	revise "Home square feet" in table 3-189 to "building square feet"	Corrected
162	NJ Utilities Association (NJUA)	3.6.1	418	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: table 3-190	No source reference provided for values in table 3-190. The link "104" does not match any references.	Updated
163	NJ Utilities Association (NJUA)	3.7.1	418	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Midstream Baseline Wattages, Appendix J	There are two (2) Appendix J in this document, ISR and Midstream Baseline Wattages. Suggest renaming Midstream Baseline to Appendix L.	Corrected
164	NJ Utilities Association (NJUA)	3.6.1	419	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: table 3-191	Update references in table 3-189 for coincident factor and gas peak day factor to "Lookup in Table 3-191", not in table 3-190	Corrected
165	NJ Utilities Association (NJUA)	3.7.1	421	C&I	Lighting	Lighting Fixtures	LPD_AF and NTG	The LPD_AF is an adjustment factor that reduces the code LPD allowance to account for standard practice. This is not unreasonable, although many jurisdictions use the code baseline as the basis for gross impacts and use NTG to account for standard practice. Not contesting the application of LPD_AF as stated in the protocol but note that both deemed NTG values and NTG studies would need to reflect the LPD_AF term. Since the LPD_AF adjusts for what people would do in the absence of the program, it acts as a free ridership term. Therefore, the NTG table in Appendix H would need to distinguish between new construction and retrofit, and new construction would have higher NTGs. Also, NTG surveys for new construction lighting would need to somehow distinguish that, if a customer states that they would have done all or part of the new const. lighting project without the program, to what extent is that already reflected in the LPD_AF factor.	NMR confirms that NTG (per NMR study) allows for ISP baseline (as opposed to code)
166	NJ Utilities Association (NJUA)	3.7.1	421	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Energy Efficient Wattage	I believe there needs to be clarification regarding the source of the EE wattage used. Manufacturer specs or DLC/Energy Star listings? But efficient condition should not require DLC/ES compliance.	Updated language: "wattage per DLC or ENERGY STAR certification, or manufacturer's cutsheet if certification not required by program"
167	NJ Utilities Association (NJUA)	3.7.1	423	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Table 3-192, HVAC g	Update look up table reference.	Corrected
168	NJ Utilities Association (NJUA)	3.7.1	423	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Table 3-192, EUL	Update EUL reference value in table.	Corrected
169	NJ Utilities Association (NJUA)	3.7.1	424	C&I	Lighting	Lighting Fixtures	Table 3-192 link	HVACg refers to Table 1-8 and is not a link	Corrected
170	NJ Utilities Association (NJUA)	3.7.1	424	C&I	Lighting	Lighting Fixtures	Table 3-192	EUL reference value incomplete	Corrected
171	NJ Utilities Association (NJUA)	3.7.1	425	C&I	Lighting	Lighting Fixtures	Table 3-193 & 3-194	Building Area Method and Space by Space Method were designed for different use-cases by ASHRAE. Consider adding guidance for when to use each table.	Added description
172	NJ Utilities Association (NJUA)	3.7.1	427	C&I	Lighting	Lighting Fixtures	Table 3-196	This method of exterior lighting power calculation has specifics that are not explained in the measure language. Consider adding detail to clarify how the attributes (base site allowance, tradeable vs nontradeable etc) are to be used	Added description
173	NJ Utilities Association (NJUA)	3.7.1	428	C&I	Lighting	Lighting Fixtures	Table 3-197 MF CF	Isn't MF "In-Unit" CF covered in section 2.4.1 Table 2-113? Here it reads 0.59, there = 0.06	Changed to 0.06
174	NJ Utilities Association (NJUA)	3.7.1	428	C&I	Lighting	Lighting Fixtures	Table 3-197	C&I Lighting Fixtures: Operating hours for C&I Lighting for "Museums", "Restaurant - Dine-In" & "Restaurant - Fast food" should be added.	Added
175	NJ Utilities Association (NJUA)	3.7.1	429	C&I	Lighting	Lighting Fixtures	Table 3-198 HVACg for MF	Should we use the "Mid-Stream/Other" row for MF Common Areas? What about MF In-Unit (is that covered in section 2.4.1)?	Added a line in the footnote and a line in the description so that the user doesn't miss this important note

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176	NJ Utilities Association (NJUA)	3.7.1	430	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Table 3-199	Address prior comment: "If you compare large retrofit oil to large retrofit gas the oil impact is twice as big as gas impact, but for small retrofit its 1/10 as big. Seems odd, double check that these values are correct. Could not find them in any reference." Response indicates using NY TRM which uses blanket -0.002 factor, but do not see any updates made.	Updated to use NY TRM HVACg, consistency throughout TRM checked
177	NJ Utilities Association (NJUA)	3.7.1	430	C&I	Lighting	Lighting Fixtures	Table 3-199 HVACg for MF	Should we use HVACg from the Res section 2.4.1 for MF In-Unit? What about MF Common (rental office vs int hallway)? Please note the units of HVACg_com are different than HVACg_Res.	Updated to use NY TRM HVACg, consistency throughout TRM checked
178	NJ Utilities Association (NJUA)	3.7.1	430	C&I	Lighting	Lighting Fixtures	Table 3-199	Unknown row is off by a factor of 10	Corrected
179	NJ Utilities Association (NJUA)	3.7.2	434	C&I	Lighting	Lighting Controls	Lighting Controls: Annual Fuel Savings	Could the same algorithm be used for the fuel penalty algorithms? Using different algorithms both based on HVAC_g seems incorrect. Because the 0.00073 factor is undefined, its not clear how the Networked Lighting Therms algorithm works, but suspicious that the HVAC_g factor is in numerator in one and denominator in the other.	Updated to use NY TRM HVACg, consistency throughout TRM checked
180	NJ Utilities Association (NJUA)	3.7.2	436	C&I	Lighting	Lighting Controls	Lighting Controls: Measure Life	The algorithms in this chapter, using prescribed savings factors directly, are not suitable for a dual baseline. Lighting controls isn't really suited to a dual baseline and that is not a common industry practice.	Removed dual baseline and updated measure life
181	NJ Utilities Association (NJUA)	3.7.2	436	C&I	Lighting	Lighting Controls	Table 3-205	C&I Lighting Controls: The operating hours for C&I lighting measures is inconsistent throughout the document. Table 3-205 should follow Table 3-197. Table 3-197 was revised based on 1st round of comments.	Updated
182	NJ Utilities Association (NJUA)	3.7.2	437	C&I	Lighting	Lighting Controls	Lighting Controls: Table 3-205	Coincidence Factors for controls savings are not the same as for lighting savings.	**NY TRM**: In Interior Lighting Control measure section, as per Pg 884, "Refer to the CF column of the table in the "Operating Hours" section of the Commercial and Industrial Interior and Exterior Lighting measure for prescribed coincidence factor for commercial indoor lighting measures based on Facility Type." This tells me CF is the same. However, for bi-level control, Parking Lot Lights: 0, Interior: 1 **PA TRM**: Also uses the same CF for both Lighting savings and lighting control savings **Mid Atlantic TRM**: also uses the same CF In conclusion, we propose to use the same CF for both lighting and lighting control measures for this year.
183	NJ Utilities Association (NJUA)	3.7.2	437	C&I	Lighting	Lighting Controls	Lighting Controls: Table 3-205	Table 3-205 (Hrs and CF for Lighting Controls) is almost identical Table 3-197 in the Lighting Chapter. Probably better for consistency purposes to just refer back to that one. Otherwise, there appears to be a typo in the Hospital Hours and CF, and the Warehouse/Small Hours. In both cases the numbers are similar but don't match whereas all the other building types match completely. The Controls table is also missing several of the space types that could be useful including Multi-family.	Updated
184	NJ Utilities Association (NJUA)	3.7.2	438	C&I	Lighting	Lighting Controls	Lighting Controls: Table 3-206, Table 3-207	Tables 3-206 and 3-207 for HVAC interactive factors are also duplicates from the previous chapter - consider just referring back to them.	Updated
185	NJ Utilities Association (NJUA)	3.7.3	443	C&I	Lighting	Delamping	Table 3-212	C&I Delamping: The operating hours for C&I lighting measures is inconsistent throughout the document. Table 3-212 should follow Table 3-197. Table 3-197 was revised based on 1st round of comments.	Updated
186	NJ Utilities Association (NJUA)	3.7.5	451	C&I	Lighting	LED Sign Lighting	LED Sign Lighting: Table 3-223, Hours	Tables references Appendix D for HVAC fan/pump hours, please update with appropriate appendix.	Corrected
187	NJ Utilities Association (NJUA)	3.7.5	451	C&I	Lighting	LED Sign Lighting	Table 3-223	Annual hours of operation (business hours) refers to Appendix D, which lists fan and pump operational hours. This is not relevant to LED signage operational hours, as fans and pumps can cycle on and off (varies by operation and design intent)	Updated
188	NJ Utilities Association (NJUA)	3.7.5	451	C&I	Lighting	LED Sign Lighting	Table 3-223	Missing annual hours of operation assumption references	Updated
189	NJ Utilities Association (NJUA)	3.7.5	452	C&I	Lighting	LED Sign Lighting	LED Sign Lighting: CF Tables and References	Multiple table reference errors throughout the document. Table 3-224 is the correct CF table, not Table 3-43	Updated

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190	NJ Utilities Association (NJUA)	3.7.5	452	C&I	Lighting	LED Sign Lighting	LED Sign Lighting: Table 3-223, Watts b	Per prior comment - baseline for unknown references neon sign, recommend adding values for fluorescent baselines.	NY TRM: Uses the neon sign wattage of 46W PA TRM: uses 45.7 (probably neon baseline) IL TRM: Same neon baseline CA Workpapers: nothing related to fluoroscent baseline Conclusion: I think its a good suggestion. I went through different trms as mentioned above. I also looked at different papers. Typical number for fluoroscent that is almost 610W which seems high to me that I'm not comfortable using. For now, I think we should still to 46W. Also, the TRM currently allows for using site specific values too.
191	NJ Utilities Association (NJUA)	3.7.6	455	C&I	Lighting	Indoor Horitculture LED	PPE_b Value	Indoor Horticulture LED measure calculation is too basic, and may significantly over/under estimate savings, depending on the lighting application. The easiest way to increase the calculation accuracy is to allow for the PPE_b value to vary based on end-use. An example of this can be seen in the Illinois TRM T11 (https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010123_v11.0_Vol_2_C_and_I_092222_FINAL.pdf) - Sec 4.1.11	Added PPE Table from IL TRM
192	NJ Utilities Association (NJUA)	3.7.6	456	C&I	Lighting	Indoor Horitculture LED	Indoor Horticulture LED: Table 3-227	Table only defines one baseline PPE_b value. My understanding is there are different light requirements for growth phases - propagation/vegetative growth/flowering that result in different baseline lighting types and therefore different baseline PPE_b.	Agreed. Addressed in above comment
193	NJ Utilities Association (NJUA)	3.8.2	466	C&I	Motors and Drives	VFD	VFD: Table 3-236, hr	Update appendix for annual run hours.	Updated
194	NJ Utilities Association (NJUA)	3.9.2	475	C&I	Plug Load	Office Equipment	Office Equipment: Table 3-246	The "Source" for each of the office equipment values is "1", it seems this should be "[580]"	Updated
195	NJ Utilities Association (NJUA)	3.9.2	475	C&I	Plug Load	Office Equipment	Office Equipment: Table 3-246	Laser color options have not been included in any of the office equipment categories. This option has more savings associated with it and should be considered as a part of the TRM for printers and multi-function devices.	Spent 30-35 minutes researching and found nothing substantial. Here are my findings: NY TRM: Nothing there Mid Atlantic TRM: Same approach as ours PA TRM: Same approach as ours CT PSD: Also relies on Energy Star IL TRM: Nothing helpful Studies that I looked at are pretty old: 1992, 1996, 1997, 2004 To conclude, we propose stick to the current methodology until a better source for algorithms with different laser colors can be identified.
196	NJ Utilities Association (NJUA)	3.9.2	475	C&I	Plug Load	Office Equipment	Office Equipment: Table 3-246	Default energy savings for "Monitor" in the calculation tool is 8 kWh, the TRM provides 24 kWh as the deemed savings value.	Changed to 8
197	NJ Utilities Association (NJUA)	3.9.3	477	C&I	Plug Load	Smart Strip	Smart Strip: 8760/168	Should consider prior comment accounting for holidays/shutdown days throughout the year. Response to comment acknowledged the merit of the comment, but stated it would consider for the future as offices might vary in terms of shut down days. Couldn't we make the value (8760/168) site specific or default to the current value if unknown?	Replaced (8760/168) with a variable called Wks: Weeks the office is open during the year, to allow for site-specific input
198	NJ Utilities Association (NJUA)	3.9.3	481	C&I	Plug Load	Smart Strip	Smart Strips:	The reference to the source [585] does not seem to be used in the Smart Strips measure. Table 3-251 references [586] and [587].	Updated
199	NJ Utilities Association (NJUA)	3.9.3	481	C&I	Plug Load	Smart Strip	Smart Strips:	The reference [586] is used in this and various other TRMs, but the document does not seem to exist online. Cannot verify any claims made from the results of this source.	Reviewed other TRMs and searched for recent studies, could not find better source
200	NJ Utilities Association (NJUA)	3.9.4	483	C&I	Plug Load	Uninterruptible Power Supply	Uninterrupted Power Supply: Table 3-252	Footnote 124 does not adequate explain how Table 3-252 arrives at the EFLH values. What location and methods are used to determine EFLHs? Are they EFLHs used in equation 124 derived elsewhere in the TRM? How are the EFLHs divided into test load bins of 25% 50% 75% and 100%?	Added the following note: The EFLH values were derived using the following equation EFLH = (t0.25 x 0.25 + t0.5 x 0.5 + t0.75 x 0.75 + t1.0 x 1.0) x 8760 hours. The time spent at specified proportion of reference load (t) was sourced from the ENERGY STAR Uninterruptible Power Supplies Final Version 2.0 Specification document. The 8760 hours assumption is based on the fact that the power is uninterruptible, therefore available year-round, i.e 8760 hours a year.

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201	NJ Utilities Association (NJUA)	3.9.7	491	C&I	Plug Load	Electric Vehicle Chargers	Table 3-260 Calculation Parameters - N_evse	Number of EVSE value in table is N/A, should not be. Should be site specific or deemed	Updated
202	NJ Utilities Association (NJUA)	3.9.7	491	C&I	Plug Load	Electric Vehicle Chargers	Electric Vehicle Charger:	This reference is from nearly a decade ago. At the time, public EVSE saw 7,200 kWh annually. Applying 5.6% savings from upgrading to level 2 charging from level 1 yields a deemed savings of 403 kWh. Is a more updated reference available?	This was the best-available source identified during tech review. Further research recommended.
203	NJ Utilities Association (NJUA)	3.10.5	507	C&I	Refrigeration	Strip Curtains	Strip Curtains: Table 3-280	kWh/ft2 for "Refrigerated Warehouse - Cooler" is calculated 876.37 in the reference but displayed as 153.36 in the TRM.	Updated
204	NJ Utilities Association (NJUA)	3.10.5	508	C&I	Refrigeration	Strip Curtains	Strip Curtains:	Energy Savings for Pre-Existing Curtains values in Table 3-280 are based on a efficacy value or 58%. The source provided for this value suggests an efficacy value of 54.1%. https://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf	Updated
205	NJ Utilities Association (NJUA)	3.10.13	539	C&I	Refrigeration	VFD Compressor	VFD Compressor:	Reference [154] has moved websites. Hyperlink directs to an inactive webpage.	Updated
206	NJ Utilities Association (NJUA)	3.11.1	539	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Delta T amb	Please clarify confusion regarding delta T amb. Many prior comments/responses indicate this value was removed from the calculations, however value is still present. If used, equation needed to calculate the value needs to be added to the measure.	Updated
207	NJ Utilities Association (NJUA)	3.11.1	539	C&I	Water Heating	Storage Tank Water Heater	Description	Paragraph 2 in the Description section seems to have an error, citing eligible storage heaters with both greater than 75 kBTUh and less than 4 kBTUh. Additionally, electric water heaters are described in both kW and BTUh units. Consider revising.	Updated
208	NJ Utilities Association (NJUA)	3.11.1/2/3/5	539	C&I	Water Heating	Multiple	Multiple: Storage Water Heater, Tankless, Heat Pump, and Combination Boiler: Setpoint Temperature	Should there be different setpoint temperatures, if unknown? Storage and Heat Pump Water Heater measures state 140F, where Tankless and Combi measure state 125F.	Updated
209	NJ Utilities Association (NJUA)	3.11.1	541	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Table 3-314, Standy Loss	Units for SL b and SL q should be stated in table.	Updated
210	NJ Utilities Association (NJUA)	3.11.1	541	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Table 3-314, Baseline Thermal Efficiency	Ditto regarding prior comment that existing age and efficiency might be unknown and the measure states if efficiency unknown, use code based on equipment age. This is vague and should be further defined.	Updated to include guidance to assume 2/3 EUL
211	NJ Utilities Association (NJUA)	3.11.1	541	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater:	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
212	NJ Utilities Association (NJUA)	3.11.1	542	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Table 3-117 PDF	Updated PDF value and reference Appendix G.	Updated
213	NJ Utilities Association (NJUA)	3.11.1	543	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: References	A few references cited (223, 229, 336) are not present in the list at the end of the measure. It would be helpful to be able to reference the source without scrolling through the entire document to locate the reference in another measure.	Updated link to references
214	NJ Utilities Association (NJUA)	3.11.2	547	C&I	Water Heating	Tankless Water Heater	Tankless Water Heater: CF Reference	Reference for CF value in Table 3-318 is for measure life, please update to appropriate source.	Updated
215	NJ Utilities Association (NJUA)	3.11.2	551	C&I	Water Heating	Tankless Water Heater	Tankless Water Heater: Table 3-318	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
216	NJ Utilities Association (NJUA)	3.11.3	553	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: Table 3-322, F heat/cool	F heat and F cool values stated in table need reference.	Updated
217	NJ Utilities Association (NJUA)	3.11.3	553	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: Table 3-322	Was there thought put into prior comment regarding constraints of GPD values stated in the table? Comment author suspects stated values are gallons of water, not hot water. Was this investigated? Comment suggests there needs to be a reasonable limit on GPD aligning with the rated capacity of the HPWH.	Source of GPD values does not specify. Good suggestion to limit GPD based on rated capacity of HPWH - updated
218	NJ Utilities Association (NJUA)	3.11.3	553	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: Table 3-322	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
219	NJ Utilities Association (NJUA)	3.11.3	558	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: PDF	Update table 3-332PDF value to Appendix G	Updated
220	NJ Utilities Association (NJUA)	3.11.4	560	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Description - MF in-unit	Per prior comment, there should be a note in the measure description addressing the fact that MF in-unit faucets/showerheads can be addressed in the residential protocol.	Updated
221	NJ Utilities Association (NJUA)	3.11.4	561	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: CF	there should be consideration of a CF for electric water heating.	Updated

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222	NJ Utilities Association (NJUA)	3.11.4	561	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Table 3-334, Operating Days/Year	Days fixture used per year should reference table 3-336, not 3-344.	Corrected
223	NJ Utilities Association (NJUA)	3.11.4	562	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Table 3-337	Reference needed for PDF.	PDF linked to appendix
224	NJ Utilities Association (NJUA)	3.11.4	564	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Table 3-336, Operating Days/Year	Source needed for operating days/year based on facility type.	Based on NJ prototype building models, clarification added
225	NJ Utilities Association (NJUA)	3.11.5	564	C&I	Water Heating	Combination Boiler	Combination Boiler: Table 3-339	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
226	NJ Utilities Association (NJUA)	3.11.6	572	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-343, 8.33	Units for pounds/gal of water. lb/gal	Corrected
227	NJ Utilities Association (NJUA)	3.11.6	572	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-343, Days/year	Look up in table 3-345, not 3-344.	Corrected
228	NJ Utilities Association (NJUA)	3.11.6	573	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-343, Days/year	Reference needed for values	Updated
229	NJ Utilities Association (NJUA)	3.11.6	574	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-347	Reference needed for PDF.	PDF linked to appendix
230	NJ Utilities Association (NJUA)	3.12.1	593	C&I	Process	VSD Air Compressors	VSD Air Compressors	Further research needed per prior comment regarding source of values referencing motors </= to 40HP, while measure includes motors up to 100HP.	Updated to include larger hp range
231	NJ Utilities Association (NJUA)	3.12.2	596	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection: Table 3-367	recommend updating table to match the leakage Rates table (table 6, pg 17) from Chapter 22: Compressed Air Evaluation Protocol from the Uniform Methods Project. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwje6-f_5pD-AhU3HDQIHX8NCd0QFnoECAcQAQ&url=https%3A%2F%2Fwww.nrel.gov%2Fdocs%2Ffy17osti%2F68577.pdf&usg=AOvVaw3zsfwWDE8agqj2JjL5syow	Agree with this comment. Updated reference to the recommended source. The source we initially used is from 2004, while the source they are recommending is from 2013
232	NJ Utilities Association (NJUA)	3.12.2	596	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection	Recommend updating table to match the adjustments factor table (table 5, pg 16) from Chapter 22: Compressed Air Evaluation Protocol from the Uniform Methods Project. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwje6-f_5pD-AhU3HDQIHX8NCd0QFnoECAcQAQ&url=https%3A%2F%2Fwww.nrel.gov%2Fdocs%2Ffy17osti%2F68577.pdf&usg=AOvVaw3zsfwWDE8agqj2JjL5syow	Updated
233	NJ Utilities Association (NJUA)	3.12.2	596	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection:	Unable to find the value in the reference documentation for the electric coincidence factor. The UMP chapter 2 compressed air evaluation protocol does not provide a recommendation for coincidence factor. In the absence of data to backup the 0.846 coincidence factor, recommend using the annual hours divided by 8,760 as the coincidence factor.	Updated
234	NJ Utilities Association (NJUA)	3.12.2	598	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection: References #1	Reference #1 link is an error. Update to: https://www.energystar.gov/sites/default/files/buildings/tools/compressed_air3.pdf	Updated
235	NJ Utilities Association (NJUA)	3.13.1	600	C&I	Whole Building	Combined Heat and Power	Combined Heat and Power:	This measure is currently under revision per comments received on 3/6/2023 on preliminary draft.	Measure will be revised per comments received on draft and added to TRM
236	NJ Utilities Association (NJUA)	5	616	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	DOE-2	Appendix B: Building Prototype Descriptions relies on DOE-2.2 as the energy modeling software. This platform is no longer maintained or updated, and the industry has generally moved to EnergyPlus. We are advising that NJ does the same, or lays a plan to do so for future iterations of the TRM	Agree simulation platform deserves a closer look given industry movement toward EnergyPlus. The SWE has an HVAC full load hour research project planned and we will address this issue when developing the project.
237	NJ Utilities Association (NJUA)	5	616	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	DOE-2	Appendix B indicates that the 2004-05 California DEER study was used to develop the building energy models. The DOE currently maintains up-to-date energy models on the EnergyPlus platform, available in all climate zones and multiple code performances. Consider utilizing these models in the future to ensure model consistency and accuracy. Note: some modification will be required for vintages. https://www.energycodes.gov/prototype-building-models	Agree the DOE prototypes might be a better fit than the updated DEER prototypes. This along with the movement to EnergyPlus will be addressed in a future HVAC full load hour study.
238	NJ Utilities Association (NJUA)	5	616	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototypes	Some of the building prototype models do not seem to have exterior glazing in the renderings (dormitory and large office). Please confirm intent and revise if needed.	All prototypes have exterior glazing defined. Renderings updated to display the exterior glazing.

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239	NJ Utilities Association (NJUA)	6	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C	Heating EFLH for dual-fuel heat pumps likely needed in the future. And would be useful now for program planning and design (e.g. even simply a % of annual heat load provided by fossil fuel vs heat pump)	We have an HVAC full load hour study planned and will investigate compressor and fossil fuel heating FLH data for dual fuel heat pumps.
240	NJ Utilities Association (NJUA)	6.1.1	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-1	Regarding the heating EFLH value for old buildings prior to 1979 for MF Highrise the NY TRM v10 the EFLH lists 513 for buildings built before 1979. The heating EFLH in this table (987) matches the pre-war uninsulated brick building value listed in then Ny TRM v10. Should this be the appropriate value?	Will revert to heating and cooling EFLH from previous NJ protocol for this measure and will ensure EFLH values are consistent throughout residential section. HVAC EFLH will be studied in a future project
241	NJ Utilities Association (NJUA)	6.1.1	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-1	Need weighted averages over 'Home Type' for midstream delivery when participant contact information is not available for surveys (e.g. Point-of-Sale Smart Thermostat discounts).	RECS data used to develop home type weights and weighted averages provided for midstream programs.
242	NJ Utilities Association (NJUA)	6.1.1	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-1 Res FLH	Please indicate whether the MF values are only applicable to "In-Unit" (i.e. dwelling unit) hours and MF Common Areas are addressed in the C&I section.	Clarifying language added.
243	NJ Utilities Association (NJUA)	6.1.2	648	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-3 B/T Corr. Example	Please include some MF examples in this table. For instance, MF Rental Office - should we use 'Small Office' or 'Multi-family low-rise'? What about interior hallways (different setpoints than rental office)?	Clarifying language added.
244	NJ Utilities Association (NJUA)	6.1.3	650	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C - Table 6-4	Table 6-4 Auto repair EFLH_h seems high.	Auto repair prototype has large outdoor air fraction driving up the heating full load hours.
245	NJ Utilities Association (NJUA)	6.1.3	651	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-6 MF EFLH	Please add the word "Average" to the middle column of hours ('From 1979 to 2006'), consistent with Table 6-1	Updated
246	NJ Utilities Association (NJUA)	6.1.3	651	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-6 MF EFLH	Please indicate whether these hours include MF Common Areas. They don't match the hours in the Res table (6-1) leading the reader to assume these are weighted averages.	The Multifamily Highrise prototype includes common areas and can be used for that application.
247	NJ Utilities Association (NJUA)	6.1.3	651	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C - Table 6-6	Table 6-6 EFLH for highrise MF suggests the assumption is that newer buildings have heating systems that are significantly oversized compared to other building types. Is this correct?	Oversizing assumptions were held constant across the vintages. EFLH is generally lower due to reduced exterior shell to conditioned floor space ratio for multifamily buildings
248	NJ Utilities Association (NJUA)	6 & 7	Multiple	Appendix C (EFLH), Appendix D (hours)	Appendix C (EFLH), Appendix D (hours)	Appendix C (EFLH), Appendix D (hours)	Appendix C & D EFLHs	Appendix D assigns a system fan and pump EFLH by C&I facility type and local climate, while Appendix C uses facility type and HVAC type (no climate consideration). Consider editing one or both of these appendices to be consistent with one another.	Appendix C updated to include EFLH by climate zone
249	NJ Utilities Association (NJUA)	8.1	661	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-1	Is it possible to provide the underlying formulas? A formulaic approach facilitates applications such as tracking and reporting data review and related analysis.	The SEER to SEER2 and HSPF to HSPF2 equivalents were based on a market analysis rather than a calculation. Interpolation of the values or a regression equation based on the tabular data is acceptable.
250	NJ Utilities Association (NJUA)	8.2	661	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Central AC, ASHP, Mini-Splits, PTAC, PTHP: Appendix E - 8-1	No conversions present for EER/EER2.	EER2 to EER conversion guidance added to Appendix E.
251	NJ Utilities Association (NJUA)	8.2	661	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP: Appendix E - 8-1	No conversions present for EER/EER2.	EER2 to EER conversion guidance added to Appendix E.
252	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2	2019 Minimum Heating Efficiencies for ASHP > 135,000 Btu/h and < 240,000 Btu/h. Should the 3.2 COP be 3.3 COP? There is a typo in ASHRAE 90.1 2019 that makes it confusing.	Efficiencies reviewed and updated as necessary
253	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2	I can't find EERb referred to in sec 2.3.1 Table 2-60 for units < 65 kBtuh. I also can't find CEERb referred to in the same table.	Efficiencies reviewed and updated as necessary
254	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2	'2013 Minimum Cooling Efficiency' for <65kBtuh Air Source ACs should be 13 SEER instead of 14 SEER.	Efficiencies reviewed and updated as necessary
255	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2 Sizing missing > = symbol for AC	> 65,000 Btu/h and < 135,000 Btu/h' - SHOULD BE '≥65,000 Btu/h and < 135,000 Btu/h' in the AC table (2nd line of Table 8-2) to capture units that are 65,000 Btu/h	Efficiencies reviewed and updated as necessary
256	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Chiller minimum efficiencies	There are no chillers represented in the minimum efficiencies table, when they are present in the reference tables in ASHRAE 90.1-2019. Consider adding them if minimum chiller efficiencies are used in any TRM calculations.	Efficiencies reviewed and updated as necessary

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
257	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Baseline	table 8-2 requires updates. For example: 2013 CAC baseline was 13 SEER in northern region 2019 was not the year of new standard (e.g. SEER2, HSPF2). Should this say 2023? Should probably separate res split central from commercial since C&I<65kbtu have different standards in 2023 Residential and commercial DHW have different standards not adequately addressed in table 8-5	Efficiencies reviewed and updated as necessary
258	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Hot Water-Gas Fired <300 size 2019 Min Efficiency ASHRAE lists 82%, where is 84% from?	Efficiencies reviewed and updated as necessary
259	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Hot Water-Oil Fired <300 size 2019 Min Efficiency ASHRAE lists 84%, where is 86% from?	Efficiencies reviewed and updated as necessary
260	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam-Gas Fired <300 size 2019 Min Efficiency this appears to be 80% in ASHRAE. Where is 82% from?	Efficiencies reviewed and updated as necessary
261	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam-Gas Fired Natural Draft ≥300 and ≤ 2,500 category under 2013 Min Efficiency 77% appears in ASHRAE 90.1.	Efficiencies reviewed and updated as necessary
262	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam- Gas Fired Natural Draft >2,500 category under 2013 Min Efficiency 77% appears in ASHRAE 90.1.	Efficiencies reviewed and updated as necessary
263	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam-Oil Fired <300 category under 2013 Min Efficiency ASHRAE has 82%. Where is 85% from?	Efficiencies reviewed and updated as necessary
264	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Gas Fired 2013 MIn Efficiency ASHRAE says 78% AFUE or 80% Et. Should Et be included as well?	Efficiencies reviewed and updated as necessary
265	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Oil Fired ASHRAE says 78% AFUE or 80% Et. Should Et be included as well?	Efficiencies reviewed and updated as necessary
266	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Oil Fired 2019 MIn Efficiency which section of code specifies AFUE for nonweatherized mobile homes?	Efficiencies reviewed and updated as necessary
267	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Oil Fired 2013 Min Efficiency this is true in ASHRAE 90.1 2013 but it changes in ASHRAE 2019: 80% before 1/1/2023 and 82% after 1/1/2023. It seems odd that the pre 2023 efficiency requirement dropped from 81% to 80% between ASHRAE 2013 and 2019. I'm not sure that this needs to change but I don't know why the newer ASHRAE has different values so I'm mentioning it.	Efficiencies reviewed and updated as necessary
268	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	For Furnace Type Gas Fired, Oil Fired this category is a little confusing. How is it different than the other gas fired and oil fired furnaces? Is this for unit heaters?	Efficiencies reviewed and updated as necessary
269	NJ Utilities Association (NJUA)	9	666	Appendix F: HVAC Interactivity Factors	Appendix F: HVAC Interactivity Factors	Appendix F: HVAC Interactivity Factors	Appendix F	Some measures in the TRM already have interactive factors listed in the specific measure (Pg. 123 Table 2-107). Need clarification on when to use the interactive values in the measures vs. the value in Appendix F, especially if the values conflict.	Efficiencies reviewed and updated as necessary
270	NJ Utilities Association (NJUA)	10	668	Appendix G: Natural Gas Peak Day Factors	Appendix G: Natural Gas Peak Day Factors	Appendix G: Natural Gas Peak Day Factors	Natural Gas Peak Day Factors	Peak day factors: The values for Type 2 look too high in many cases, see table 10-10. Factors in the range of 0.06 mean 6% of total therm use (or EFLH) and savings occur on the peak day. EFLH can't be higher than 24 hours. We did not review all values, but there are definitely issues with some numbers. for example: VAV, high school, central region, pdf is 0.09. that suggests the total annual heating eflh is 24hrs/0.09 = 266.7 EFLH. All heating runtime values (there are no highschool EFLH values in TRM) are much higher than 266. So it's not clear how 0.09 was derived. Regardless, without justification, this any many other values are too high Why should the PDFs be specified in far more detail for gas compared to electric? Many measures have a single electric demand CF, but PDFs are specified by building type AND hvac system AND climate zone. Preferably, the specific factors would be dispersed into the TRM wherever possible or if there's too many of a single measure, then the measure definition should point directly to the relevant table of PDFs in the appendix (i.e.	Issues investigated and revisions made to Appendix G. Weighted average values across climate zones and HVAC types provided.

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
271	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for HPwES Projects	Each individual measure that is part of HPwES projects has its own different NTG value listed in the table; however SnuggPro software may not be able to be modified to apply individual measure NTG values in the software. Is one NTG value for HPwES projects possible if SnuggPro software cannot be modified or it is too costly to modify?	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
272	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H	Suggest eliminating the Unique ID# column, this was used in the NJ CML that will no longer be used once the NJ TRM is updated.	Corrected
273	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H	Define column "PA" or remove	Corrected
274	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Custom	Custom NTG. We suggest one value for custom and do not agree with the assumed rapid commercialization adjustment for any custom measure. If measures are rapidly adopted, they would be well-suited for prescriptive program. Custom projects are inherently unique and therefore the assumption that rapid adoption occurs is not logical.	There should be more than one custom value to represent the assortment of situations. Regarding commercialization, the utilty evaluators may undertake future utility-specific evaluation studies to identify more specific levels.
275	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Residential Retrofit	Do not agree with adjustments (e.g. heat pump increase) for residential retrofit. The default assumption is that the action taken is comprehensive whole-home improvements, and one NTG value would be preferable for the program. It's not advisable to attempt measure-specific NTG values because we would have to de-couple modeled savings to apply the NTG values. If that is the expectation, the TRM should include method to do so.	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
276	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG Residential Direct Install	Residential direct install measure NTG values, especially moderate income, seem relatively low. We'd expect DI to have the highest NTG. Of interest: why is contractor incentive in the NTG list? with NTG =0, is the expectation that the NTG factor may be applied to the cost (there is no savings) in cost/benefit analysis?	The utilities should conduct studies to measure for their own experiences. The hybrid incentive approach accounts for the contractor incentive. That is why the hybrid approach gets a higher NTG than without it.
277	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG QHEC	QHEC Lighting DI measures. NTG is 0.15, 0.08, 0.04 Why are these any different from other QHEC measures? The program removes existing, operating inefficient bulbs meaning the new standard baseline is not relevant until end of RUL. Was that not addressed by update to lifetime hours (AML)? Other QHEC measures also seem relatively low. Pipe wrap or shower thermostatic valve NTG of 0.6 is not logical. We'd expect much closer to 1.0 for these measures	Because lighting is facing federal standard change, and if the custom kept them in place, they would likely burn out and replace with an LED. The utilities should conduct studies to measure for their own experiences.
278	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: NTG Building Improvements	What does "Building Improvements" include? Or what does it not include? It does not have a value for Electric NTG	Building improvements is the term used in the coordinated measure list. We assume it is mostly building shell measures. The literature did not support an electric-specific improvements estimate, so the utilites should default to "custom - other" for electric.
279	NJ Utilities Association (NJUA)	12	766	Appendix I: Realization Rates	Appendix I: Realization Rates	Appendix I: Realization Rates	Appendix I - Realization Rates	There are many versions of kits which have different measures and different delivery mechanisms. We will suggest removing kits from RR table. ISR and fuel type % assumption are the key parameters, RR is unnecessary.	Realization rates reviewed and updated based on supporting data received.
280	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J ISR	Missing measure ISR's: Advanced Power Strips, QHEC, SJG Pipe Insulation, QHEC, ETG and SJG	ISR terms added to equations as needed.
281	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J ISR	Aerator bathroom QHEC ETG listed twice.	Corrected
282	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J ISR	Aerator kitchen QHEC ETG listed twice with different values. 1.0 matches ADM's report.	Corrected to 1.0
283	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J	ISRs in the table came from evaluation. If measures are not provided in this table, should we use the ISR in the measure? Guidance needs added to each measure to explain when to use the ISR listed in the measure vs. when to use the ISR in Appendix J.	Guiding language added

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
284	NJ Utilities Association (NJUA)	14	776	Appendix K: DHW and Space Heat Fuel Split	Appendix K: DHW and Space Heat Fuel Split	Appendix K: DHW and Space Heat Fuel Split	Appendix K	Appendix K is not mentioned in any of the measures in the TRM. Is clarification needed on when to use default values in the measure and when to use the value in Appendix K? And if a measure is missing from Appendix K, do all the individual measures have default or unknown values to use?	Fuel factor should be used in lieu of default values where listed. Default values added where missing
285	NJ Utilities Association (NJUA)	15	778	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Appendix Name	The letter should be L instead if J	Corrected
286	NJ Utilities Association (NJUA)	15.2	783	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Formatting	Need a page break before this section starts	Corrected
287	NJ Utilities Association (NJUA)	General	global	General	General	General	TMY data	TMY3 data is referenced for use throughout. The industry is moving towards TMYx, so it may be wise to update at this time. This will allow for more accurate savings calculations relative to current climate conditions.	Movement to TMYx will be investigated as part of heating and cooling full load hour update project
288	NJ Utilities Association (NJUA)	General	global	General	General	General	Naming convention	Throughout the TRM document, Energy Star is depicted in a number of different ways: EnergyStar, ENERGYSTAR, Energy Star, ENERGY STAR etc. Consider updating for consistency.	Updated to ENERGY STAR throughout
289	Aeroseal	2.3.6		Residential	HVAC	Duct Sealing and	Use of site specific results	Aeroseal requested inclusion of a savings algorithm based on test in/ test out duct leakage data.	Measure calculations accomdate test in / test out duct leakage measurements.
290	Aeroseal	3.5.xx		C&I	HVAC	Duct Sealing and	Add the measure	Aeroseal requested a C&I duct sealing measure based on test in / test out duct sealing results	C&I duct sealing measure added
291	Dandelion Energy	2.3.2		Residential	HVAC	Ground Loop and	EFLH	Dandelion energy requested a revision to the heating and cooling full load hour data	An HVAC heating and cooling full load hour study is planned as part of the SWE overall evaluation plan.
292	Honeywell	General		Appendix H: Net-to-Gross Factors	General	General	Net to gross ratios	Honeywell requested removal of NTG appendix from TRM	Addressed as a policy issue in the comment response
293	Honeywell	3.12.1		C&I	Whole Building	bined Heat and P	Add emission factors	Honeywell requested adding emission factors	Emission factors included in the CHP section
294	Honeywell	1.8		General	General	General	Baselines for early replacement projects	Honeywell requested coverage of early replacement projects using existing equipment baselines	Early replacement (EREP) baseline included in the introduction and applicable measure sections.
295	MaGrann	2.1.10		Residential	HVAC	om Air Condition	Equation error	MaGrann requested an change to the Room AC with central controls savings algorithm	Change has been implemented
296	MaGrann	2.8.3		Residential	Whole Building	New Construction	EnergyStar version numbers	MaGrann requesed removing references to a specific EnergyStar specification version	EnergyStar specification numbers will be updated as needed during the TRM annual review process.
297	Recurve	3.13.4		C&I	Whole Building	Custom	Inclusion of OpenEEMeter platform	Recurve requested addition of the OpenEEMeter platform to the C&I custom measure description	OpenEEMeter is an implemenation of the IPMVP Option C M&V protocol which is already covered in the C&I Custom section. Language added to clarify
298	Recurve	2.8.x		Residential	Whole Building	Custom	Add measure	Recurve requested addition of the OpenEEMeter platform as a residential measure	Measure section added
299	NJ Business & Industry Assn (NJBIA)	General		Appendix H: Net-to-Gross Factors	General	General	Net to gross ratios	NJ Business & Industry Assn (NJBIA) requested removal of NTG appendix from TRM	Addressed as a policy issue in the comment response
300	NJ Large Energy Users Coalition	General		Appendix H: Net-to-Gross Factors	General	General	Net to gross ratios	NJ Large Energy Users Coalition requested removal of NTG appendix from TRM	Addressed as a policy issue in the comment response
301	Uplight	2.8.1		Residential	Whole Building	Behavioral	Missing document	Uplight requested access to the Behavioral Guideline document	Behavioral Guideline available on the BPU website
302	Uplight	General		General	Whole Building	Demand response	Add measure	Uplight requested additional guidance on demand response program requirements	Demand response guidelines not in TRM scope. Guidance will be provided separately.
303	PSE&G	1.9		General	General	General	Peak demand definition	PSEG requested edits to the peak demand section and clarification that TRM coincidence factors may not conform to PJM peak demand definitioin	Language added
304	Nj Division of Rate Counsel	Appendix H: Net-to-Gross Factors		General	General	General	Net to gross ratios	NJ Division of Rate Counsel requests modifiction to Appendix H Net to Gross factors	Addressed as a policy issue in the comment response
305	JCP&L	Appendix I: Realization Rates		General	General	General	Remove Appendix I	JCPL requests removal of Appendix I	Addressed as a policy issue in the comment response
306	PSE&G	Appendix I: Realization Rates		General	General	General	Revise Appendix I	PSEG provided evidence to support updates to Appendix I	Evidence reviewed and updates made
307	South Jersey Industries	Appendix I: Realization Rates		General	General	General	Remove Appendix I	SJG and ETG request removal of Appendix I	Addressed as a policy issue in the comment response
308	South Jersey Industries	Appendix I: Realization Rates		General	General	General	Revise Appendix I	SJG and ETG provided evidence to support updates to Appendix I	Evidence reviewed and updates made
309	New Jersey Natural Gas	Appendix H: Net-to-Gross Factors		General	General	General	Net to gross ratios	NJNG requests removal of Appendix H Net to Gross factors	Addressed as a policy issue in the comment response

Attachment E: Net-to-Gross Comment Summaries and Staff Responses

Commenter	Market	End-Use	Measure	Topic / Item	Comment Summary	Response
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for HPwES Projects	Each individual measure that is part of HPwES projects has its own different NTG value listed in the table; however SnuggPro software may not be able to be modified to apply individual measure NTG values in the software. Is one NTG value for HPwES projects possible if SnuggPro software cannot be modified or it is too costly to modify?	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Custom	Regarding custom NTG, suggest one value for custom and do not agree with the assumed rapid commercialization adjustment for any custom measure. If measures are rapidly adopted, they would be well-suited for prescriptive program. Custom projects are inherently unique and therefore the assumption that rapid adoption occurs is not logical.	There should be more than one custom value to represent the assortment of situations. Regarding commercialization, the utilty evaluators may undertake future utility-specific evaluation studies to identify more specific levels.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Residential Retrofit	Do not agree with adjustments (e.g. heat pump increase) for residential retrofit. The default assumption is that the action taken is comprehensive whole-home improvements, and one NTG value would be preferable for the program. It's not advisable to attempt measure-specific NTG values because we would have to de-couple modeled savings to apply the NTG values. If that is the expectation, the TRM should include method to do so.	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG Residential Direct Install	Residential direct install measure NTG values, especially moderate income, seem relatively low. We'd expect DI to have the highest NTG. Of interest: why is contractor incentive in the NTG list? with NTG =0, is the expectation that the NTG factor may be applied to the cost (there is no savings) in cost/benefit analysis?	The utilities should conduct studies to measure for their own experiences. They hybrid incentive approach accounts for the contractor incentive. That is why the hybrid approach gets a higher NTG than without it.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG QHEC	QHEC Lighting DI measures. NTG is 0.15, 0.08, 0.04. Why are these any different from other QHEC measures? The program removes existing, operating inefficient bulbs meaning the new standard baseline is not relevant until end of RUL. Was that not addressed by update to lifetime hours (AML)? Other QHEC measures also seem relatively low. Pipe wrap or shower thermostatic valve NTG of 0.6 is not logical. We'd expect much closer to 1.0 for these measures.	Because lighting is facing federal standard change, and if the custom kept them in place, they would likely burn out and replace with an LED. The utilities should conduct studies to measure for their own experiences.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: NTG Building Improvements	What does "Building Improvements" include? Or what does it not include? It does not have a value for Electric NTG	Building improvements is the term used in the coordinated measure list. We assume it is mostly building shell measures. The literature did not support an electric-specific improvements estimate, so the utilites should default to "custom - other" for electric.

Attachment D: Technical Reference Manual Comment Summaries and Staff Responses

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
1	NJ Utilities Association (NJUA)	1.3	10	Introduction	Introduction	Introduction	Table 1-1	Need to label measure types (1,2,3) in table to support proceeding paragraph	Added numbering
2	NJ Utilities Association (NJUA)	1.5	11	Introduction	Introduction	Introduction	Whole-home	Section 1.5 addresses modeled energy savings. Consider providing additional guidance on model input parameter default values which are unknown and have an impact on modeled savings estimates. For example: default temperature setpoints. Approach to estimate heating and cooling efficiency of existing equipment whenever it is unknown default minimum R-values for shell. Very low r-values may have significant impact on savings Also consider proving guidance on reporting savings. These projects are early replacement yet there's no standardized way to report, for example, measure-level savings or EUL and RUL savings.	Simulation guidelines are out of scope for this update. Please address as a program implementation issue. Measure by measure savings requires cascading measure by measure simulations, which can be addressed as a program implementation issue. Added content addressing RUL and EUL.
3	NJ Utilities Association (NJUA)	1.8	12	Introduction	Introduction	Introduction	TOS	NJ TRM Sub team agreed to use TOS instead of Normal Replacement (NR) for terminology. There are still measures in this draft TRM that use NR instead of TOS. Suggest a scrub of NR in text and formulas and replace them with TOS. Consider adding to the TOS definition a sentence something like "TOS is sometimes referred to as normal replacement (NR)" just in case any references to NR remain by mistake.	Spot checked and all seem to have been changed. Did add the additional definition in case we missed any per recommendation.
4	NJ Utilities Association (NJUA)	1.9.1	13	Introduction	Introduction	Introduction	PJM Peak	The summer peak should align with PJM's manual 18b, page 39: *"The EE Performance Hours are between the hour ending 15:00 Eastern Prevailing Time (EPT) and the hour ending 18:00 EPT during all days from June 1 through August 31, inclusive, of such Delivery Year, that is not a weekend or federal holiday."*	Languange in introduction updated
5	NJ Utilities Association (NJUA)	2.1.2	23	Residential	Appliances	Clothes Dryer	Low Income included in Market	The TRM Sub Committee agreed to remove Low Income from Market on all measures. There are several measures in the draft TRM that still have Low-Income listed under Market. Not all instances are called out in these comments. Need to do a global removal.	Low income references removed from market description in the TRM measure sections
6	NJ Utilities Association (NJUA)	2.1.2	25	Residential	Appliances	Clothes Dryer	References List	Numbering starts with [11] instead of [1] (continuing from previous section). They don't restart at [1] until section 3.5.11 and again in 3.12.2	Fixed instances where numbering restarts for consistency
7	NJ Utilities Association (NJUA)	2.1.4	31	Residential	Appliances	Induction Range/Cooktop	Multifamily missing	Several measures that would be applicable to MF are missing MF in the Market box. Should scrub draft TRM to confirm that all measures applicable to MF have MF noted.	MF applicability has been checked and updated.
8	NJ Utilities Association (NJUA)	2.1.4	32	Residential	Appliances	Induction Range/Cooktop	Table 2-17 'F_elec,b' and 'F_fuel,b'	Need non-zero defaults for POS rebates	Non-zero defaults for POS rebates provided.
9	NJ Utilities Association (NJUA)	2.1.4	33	Residential	Appliances	Induction Range/Cooktop	Induction Range/Cooktop: measure life	EUL of 16 years for induction ranges could not be located in the reference [29]. Reference should be updated to V10 which includes EUL.	Corrected
10	NJ Utilities Association (NJUA)	2.1.5	34	Residential	Appliances	Refrigerators	NR replaced with TOS	This one example where NR still remains in the detailed measures and should be TOS.	Corrected
11	NJ Utilities Association (NJUA)	2.1.6	42	Residential	Appliances	Freezer	Table 2-25 'kWh_ex'	Need 'kWh_ex' similar to 'Refrigerators' section 2.1.5	Updated lifetime section language
12	NJ Utilities Association (NJUA)	2.1.6	42	Residential	Appliances	Freezer	Freezer: table 2-25	Need reference for the HVACc and HVACd values? MA/MMD TRM does not account for interaction effects.	Added reference: NY TRM v10
13	NJ Utilities Association (NJUA)	2.1.6	42	Residential	Appliances	Freezer	Table 2-26 caption	Typo in Table Title. "Efficienct" should be "Efficient"	Corrected
14	NJ Utilities Association (NJUA)	2.1.6	44	Residential	Appliances	Freezer	Table 2-28 'F_occ'	Need "Unknown" rather than 0 in the row where 'F_occ' = 1.00	Corrected
15	NJ Utilities Association (NJUA)	2.1.8	50	Residential	Appliances	Air Purifier	Air Purifier: table 2-34	Life therms savings are not applicable and can be removed from this table to be consistent with other measure's format.	Removed
16	NJ Utilities Association (NJUA)	2.1.8	50	Residential	Appliances	Air Purifier	Table 2-34 'Description' field	Typo in 'Description' of 'PartialPower_b' and 'PartialPower_q'. "Partial On **Model** Power" should be "Partial On **Mode** Power".	Corrected
17	NJ Utilities Association (NJUA)	2.1.8	51	Residential	Appliances	Air Purifier	Tables 2-35 and 2-36 CADR Range	The smallest Range should include 30cfm to match Energy Star (30 ≤ CADR < 100). Range endpoints should match between rows (the "less than" and "greater than or equal to" signs take care of the overlap.	Corrected

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18	NJ Utilities Association (NJUA)	2.1.10	57	Residential	Appliances	Room Air Conditioner	Room Air Conditioner: Measure description	Remove heat pump and heating verbiage if heating savings are not accounted (or add heating savings for reverse cycle units). The second paragraph describes a 5% CEER allowance for units that can be networked. It says "In these instances, the default efficient CEER would be 0.95 multiplied. It should be the base CEER that is discounted by 5%. For CEER (of the new ee measure) = use site specific (remove default option as the CEER and capacity of the new unit will be known)	Removed heat pump language, but left heating language. If we remove heating language, it may imply that units that are able to provide cooling and heating are not eligible. They should be eligible even if heating savings are not accounted for. Agree with the comment regarding 5% CEER allowance. Updated language so that 0.95 is applied to baseline CEER instead of efficient CEER
19	NJ Utilities Association (NJUA)	2.2.3	68	Residential	Appliance Recycling	Dehumidifier Recycling	Table 2-55	Need guidance when 'Manufacture Date' is unknown due to illegible nameplate.	Added "If equipment vintage is unknown, assume 2/3 EUL."
20	NJ Utilities Association (NJUA)	2.3.1	70	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	CAC,ASHP, Mini-Splits, PTAC, PTHP description	Minor typos in description and baseline case paragraph ("muli-family" "Comercial" missing period end of 2nd paragraph)	Corrected
21	NJ Utilities Association (NJUA)	2.3.1	70	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Central AC, ASHP, Mini-Splits, PTAC, PTHP: Typo	Correct typo in description (last sentence of first paragraph) low--rise.	Corrected
22	NJ Utilities Association (NJUA)	2.3.1	71	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-57 Baseline Energy Consumption	Correct typo in Mini-split heat pump, ASHP (cooling capacity < 65 kbtu/hr) baseline cooling equation. Cap should be Cap_c	Corrected
23	NJ Utilities Association (NJUA)	2.3.1	71	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Central AC, ASHP, Mini-Splits, PTAC, PTHP: OSF	Prior comments address that the savings algorithms indicate the OSF is to be used in all cases, however would likely only apply to certain HP applications. The footnotes explain this, however can foresee how this can be overlooked and cause confusion. Possibly clarify with note in the text prior to table 2-57 that OSF applies to HP.	Added the following note: The oversize derating factor (OSF) in the equations above is typically applicable for certain heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. A user with a better understanding of site specific conditions can determine whether this factor is applicable or not.
24	NJ Utilities Association (NJUA)	2.3.1	71	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-57	SEER, EER, HSPF should be SEER2, EER2, HSPF2	EER to EER2 conversion table provided in Appendix. Added a note saying use EER2/SEER2,IEER2 if available the way we did it in "Heat or Energy Recovery Ventilator"
25	NJ Utilities Association (NJUA)	2.3.1	72	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	ΔkWhEX and ΔkWhNR	ΔkWhEX and ΔkWhNR are not defined in this measure	Updated lifetime section language
26	NJ Utilities Association (NJUA)	2.3.1	72	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	ΔthermsNR and ΔthermsNR	ΔthermsEx and ΔthermsNR are not defined in this measure	Updated lifetime section language
27	NJ Utilities Association (NJUA)	2.3.1	73	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-60 OSF	Please add OSF = 1.0 for Central AC since they're not sized on heating.	Updated
28	NJ Utilities Association (NJUA)	2.3.1	73	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-60	Algorithms and variables should be for SEER2, EER2, HSPF2, etc. Formulas should be provided to convert from SEER to SEER2, if necessary (working in conjunction with Appendix E).	EER to EER2 conversion table provided in appendix Added a note saying use EER2/SEER2,IEER2 if available the way we did it in "Heat or Energy Recovery Ventilator"
29	NJ Utilities Association (NJUA)	2.3.1	73	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	SEER_b	Appendix E is missing the EER to EER2 conversion. This is needed for the utilities to calculated the kW demand savings.	EER2 to EER conversion guidance added to Appendix E.
30	NJ Utilities Association (NJUA)	2.3.1	75	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Table 2-60 CF ref	Value' field points to Table 3-132 instead of Table 2-61	Corrected
31	NJ Utilities Association (NJUA)	2.3.1	75	Residential	HVAC	Central AC, ASHP, Mini-Splits, PTAC, PTHP	Central AC, ASHP, Mini-Splits, PTAC, PTHP: References	References cited in measure can be cleaned up to reflect the list at the end of the measure. Several references are cited and not shown in the list following the measure.	Corrected
32	NJ Utilities Association (NJUA)	2.3.2	77	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Heat Pumps	Based on the baseline description, there is no TOS scenario for heat pump - all heat pumps, except for new construction, are fuel-switching. Is that the intent or expectation? i.e. this creates confusion for any midstream prescriptive-type heat pump measure. Consider separating measures so that the baselines can be clearly addressed for the various common scenarios, which are varied and complicated.	Added the phrase 'Time of Sale' in the first paragraph. With this phrase, the measure is laid out to allow for many combinations of baseline/proposed equipment. Note: Heat Pumps will receive a closer look in the upcoming study
33	NJ Utilities Association (NJUA)	2.3.2	78	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-64, Eff Circ Pump kWh	Add an ESF if VFD are present as most efficient GSHP typically have variable flow water loops, per commercial measure.	Added

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34	NJ Utilities Association (NJUA)	2.3.2	78	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-63, Eff b	Eff b value in baseline circ pump kWh equation is stated as Eff motor b throughout the measure.	Changed to Eff,motor,b
35	NJ Utilities Association (NJUA)	2.3.2	79	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Annual Fuel Savings, Therms b	See Table 2-65, not 3-106.	Corrected
36	NJ Utilities Association (NJUA)	2.3.2	79	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Peak Demand Savings	Add a DSF if VFD are present as most efficient GSHP typically have variable flow water loops, per commercial measure.	Added
37	NJ Utilities Association (NJUA)	2.3.2	79	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Peak Demand Savings	Adding to above comment, there should be an additional peak kW equation for the circ pump - per C&I measure.	Added
38	NJ Utilities Association (NJUA)	2.3.2	81	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-66, Eff motor b	Look up value in Table 2-67, not 3-108.	Corrected
39	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-66, Therms b	Therms b value can be looked up in table 2-65, not 3-106.	Corrected
40	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-66,CFs and PDF	CF c, CF pump, and PDF should reference table 2-68, not 3-132.	Corrected
41	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-63, Hrs	Appendix D is referenced to look up operating hours of pump motor. Appendix D is for C&I, and Res/MF pump operating hours are not listed. C&I measure states to add EFLH c+h, perhaps same thing here?	Guidance on residential motor run hours provided.
42	NJ Utilities Association (NJUA)	2.3.2	82	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-63, EFLH c	Seems to have wrong source cited.	NY TRM uses same hours for air source and ground source, changed hours to Appendix C: Heating and Cooling EFLH
43	NJ Utilities Association (NJUA)	2.3.2	83	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: Table 2-68	Add CF pump value and cite source.	Added
44	NJ Utilities Association (NJUA)	2.3.2	83	Residential	HVAC	Ground Loop and Air-to-Water Heat Pump	Ground Loop and Air-to-Water Heat Pump: References	Reference 86 not cited in measure but present in list. General comment to clean up references throughout measure to reflect list.	Corrected
45	NJ Utilities Association (NJUA)	2.3.5	93	Residential	HVAC	EC Motor	EC Motor: Table 2-78	Annual Energy Savings Per Fan Motor should not point to reference [108]. Perhaps this reference was meant for a different line?	Updated reference and included a note that the given energy savings were calculated by scaling savings from a study
46	NJ Utilities Association (NJUA)	2.3.5	93	Residential	HVAC	EC Motor	EC Motor: Table 2-78	For dkWh_fan, value in reference [109] Is 0.117. Clarify if some kind of scaling is in place?	Appears to be a typo. The value we originally had listed in TRM is 0.117, while the reference lists 0.116. Updated value in parameters table to 0.116 to match reference
47	NJ Utilities Association (NJUA)	2.3.5	93	Residential	HVAC	EC Motor	EC Motor: Table 2-78	LF and hrs_c should also reference [112], the NY trm	Corrected
48	NJ Utilities Association (NJUA)	2.3.5	94	Residential	HVAC	EC Motor	EC Motor: References	The NY TRM link does not work.	Corrected
49	NJ Utilities Association (NJUA)	2.3.6	96	Residential	HVAC	Duct Sealing and Duct Insulation	Duct Sealing and Duct Insulation: Dual Baseline	Dual baseline is either not applicable and this should be updated to reflect that the existing condition is baseline, or... the difference between EREP and NR need to be addressed. Terms are not defined in Table 2-82.	Removed dual baseline, updated baseline description language
50	NJ Utilities Association (NJUA)	2.3.7	101	Residential	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : References	For ASHRAE and IECC referenced, include section number and page number in text	Corrected
51	NJ Utilities Association (NJUA)	2.3.7	102	Residential	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Annual Fuel Savings	60 factor in therms savings algorithm is incorrect, needs to be removed.	Corrected
52	NJ Utilities Association (NJUA)	2.3.8	112	Residential	HVAC	Maintenance	Table 2-98	Measure life is missing for DMSHP and DMSAC units	Added
53	NJ Utilities Association (NJUA)	2.3.9	114	Residential	HVAC	Boiler Controls	Boiler Controls: Table 2-99, EFLH h	Look up in table 2-100, not 3-120.	Corrected
54	NJ Utilities Association (NJUA)	2.3.9	115	Residential	HVAC	Boiler Controls	Boiler Controls: References	Reference numbers stated in measure do not match list.	Corrected
55	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, Cap c	Reference needed for cooling capacity assumptions.	Corrected
56	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, SEER	If SEER unknown, should look up in Appendix E, not Appendix C	Corrected
57	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, F elec cool	How was the unknown value of 39% derived? The cited source does not explicitly state this value and it is unclear how it was derived.	Source clarified
58	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Take 2-110, Cap h out	Reference needed for output heating capacity assumptions.	Source clarified

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59	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Cap C (units not in tons)	Cap c should not be in tons, it should be in kBtuh	Corrected
60	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, EFLH H	Text in value column should be consistent with language in EFLH C value column.	Corrected
61	NJ Utilities Association (NJUA)	2.3.12	128	Residential	HVAC	Smart Thermostat	Table 2-110	Efficiency values in table 2-110refer to Appendix C, but Appendix C deals with EFLH estimates.	Corrected
62	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, AFUE	Reference needed for unknown values.	Reference provided
63	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, F elec heat	How was the unknown value of 15% derived? The cited source does not explicitly state this value and it is unclear how it was derived.	Source clarified
64	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-110, F fuel heat	How was the unknown value of 91% derived? The cited source does not explicitly state this value and it is unclear how it was derived.	Source clarified
65	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Table 2-111	Source needed for Appendix G PDF values.	PDF linked to Appendix
66	NJ Utilities Association (NJUA)	2.3.12	129	Residential	HVAC	Smart Thermostat	Smart Thermostat: Measure Life	Suggest adding a table consistent with other measures. As the host equipment RUL is referenced, suggest adding those values in the table as well.	Updated
67	NJ Utilities Association (NJUA)	2.4.1	133	Residential	Lighting	Lamps and Fixtures	Table 2-112 Calculation Parameters	Wattage of Baseline Fixture value - A bit confusing, is the exempt tables only applied to DI channel? Maybe reorganize to make it clear, also add language later before the exempt tables to avoid confusions.	It looks like adding the word 'Direct Install' makes it confusing so I removed it. Based on the description in the 'Baseline Section', EISA Exempt: site specific or lookup in table EISA Compliant: calculate using the 45 lumens/watt It doesn't really matter whether its DI or not because lights installed through that channel are also subject to EISA Complaince
68	NJ Utilities Association (NJUA)	2.4.1	133	Residential	Lighting	Lamps and Fixtures	Table 2-112	Please add a row for the 0.03412 factor and indicate it has units of 'Therms/kWh'	Added
69	NJ Utilities Association (NJUA)	2.4.1	137	Residential	Lighting	Lamps and Fixtures	Table 2-115 typo	Typo "ecorative" should be "Decorative"	Corrected
70	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	provide source for the assumed wattage (if unknown) of Wq.	Added source
71	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	provide source for the assumed percentage (if unknown) of SVGd	Removed SVGd because its the same as SVGe; changed value from 49 to 28 because the 2 sources average is 28, not 49
72	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	change unknown value of SVGd to 49 and indicate units as %, provide reference	Change has been implemented
73	NJ Utilities Association (NJUA)	2.4.2	142	Residential	Lighting	Occupancy Sensor	Occupancy Sensors: Table 2-119	change unknown value of SVGe to 49 and indicate units as %	Change has been implemented
74	NJ Utilities Association (NJUA)	2.5.1	147	Residential	Plug Load	Office Equipment	Office Equipment: Table 2-126	The "Source" for each of the office equipment values is "1", it seems this should be "[185]"	Corrected
75	NJ Utilities Association (NJUA)	2.5.1	147	Residential	Plug Load	Office Equipment	Office Equipment: Table 2-126	Laser color options have not been included in any of the office equipment categories. This option has more savings associated with it and should be considered as a part of the TRM for printers and multi-function devices.	Conducted a due-diligence sweep: NY TRM: Nothing there Mid Atlantic TRM: Same approach as ours PA TRM: Same approach as ours CT PSD: Also relies on Energy Star IL TRM: Nothing helpful Available studies are pretty old: 1992, 1996, 1997, 2004 To conclude, we propose stick to the current methodology until a better source for algorithms with different laser colors can be identified.
76	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment: Table 2-126	Default energy savings for "Monitor" in the calculation tool is 8 kWh, the TRM provides 24 kWh as the deemed savings value.	Changed to 8
77	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment:	The commercial office equipment measure includes the proper link to the ENERGY STAR Office Equipment Calculator. There is an option within the calculator for "Residential." Please include that calculator link in reference [185] of this measure.	Updated
78	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment:	Reference [186] links to Energy Star Computers V8.0, but is not used in the Residential Office Equipment measure. This reference is probably intended to be sited within reference [185] and/or Table 2-126	Updated
79	NJ Utilities Association (NJUA)	2.5.1	148	Residential	Plug Load	Office Equipment	Office Equipment:	Reference [187] hyperlink does not work properly. "Website Not Found"	Updated

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80	NJ Utilities Association (NJUA)	2.5.3	154	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-131	ΔkWhEREP and ΔkWhNR are used to define ΔkWhLife, but are not defined in Table 2-131	Updated lifetime section language
81	NJ Utilities Association (NJUA)	2.5.3	155	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-131	Table 2-131 lists the value of ISR as "Link to ISR appendix." However there are explicit ISR values in Table 2-132 from the MA study reference [191]. Are the values in the appendix different from the reference study? There should only have ISR in one location to avoid confusion and values not aligning down the road. Review ISR for Home Entertainment and Unspecified to 0.76 and 0.81 based on ISR+RET column in Table 16 of Ref 191, if that is the reference in ISR table.	Corrected
82	NJ Utilities Association (NJUA)	2.5.3	155	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-132	Savings for "Tier 2 - Home Entertainment Center" aligns with savings values for "Tier 2 - All" in the referenced report. Consider changing the "Tier 2 End-Use" to "Unspecified" like it is in Tier 1.	Corrected
83	NJ Utilities Association (NJUA)	2.5.3	155	Residential	Plug Load	Smart Strip	Smart Strips: Table 2-132	Deemed demand savings values (kW) do not align with reference [191] Table 1 values. Consider revising to match the referenced table.	Updated
84	NJ Utilities Association (NJUA)	2.5.3	156	Residential	Plug Load	Smart Strip	Smart Strips:	Reference [191] hyperlink does not work properly. "404 cannot be found"	Corrected
85	NJ Utilities Association (NJUA)	2.5.4	158	Residential	Plug Load	SoundBar	Soundbar: Reference	Reference [193] hyperlinks to an Energy Star website rather than the PDF written in the reference. Change the hyperlink to direct to the PDF.	Unable to find version 2 of this paper to reference. Unable to find 7 year EUL in future editions
86	NJ Utilities Association (NJUA)	2.5.4	158	Residential	Plug Load	SoundBar	Soundbar: Baseline	Table 2-135 indicates 77 kWh/year soundbar baseline energy consumption referenced in [193]. There is no indication in this reference of baseline soundbar energy consumption.	Tracked down a workpaper with base case of 82 kwh/yr and post case of 29 kwh/yr, changed the reference
87	NJ Utilities Association (NJUA)	2.5.4	159	Residential	Plug Load	SoundBar	Soundbar: Reference	Reference [195] "Per NY TRM: "No source specified – update pending availability and review of applicable references." How does the TRM arrive a CF of 0.8 without this reference?	The NY TRM uses 0.8 as a blanket assumption when CF is unknwown. We are using the NY TRM for this measure because a better alternative is not available at this point.
88	NJ Utilities Association (NJUA)	2.5.5	160	Residential	Plug Load	Electric Vehicle Chargers	Annual Electric Energy Savings Equation	Second term in equation is (Hrs_PS * W_q,p * Hrs_US * W_q,u,) Should be (Hrs_PS * W_q,p + Hrs_US * W_q,u,)	Corrected
89	NJ Utilities Association (NJUA)	2.6.1	163	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-Rise Multifamily Air Sealing Description	The measure focuses on the inclusion of a blower door test. For clarity, either include a separate method for no blower door test, or move footnote 39 which provide default value in the main body and/or in the calculation parameter table	The reason why CFM50 = 0.50 x SF is not in the main body is to make sure the user defaults to using the blower door test to come up with CFM50 instead of directly calculating using this equation. In the parameter table, I replaced the word 'Calculated' with the equation itself and left the footnote as is to provide clarification to the user
90	NJ Utilities Association (NJUA)	2.6.1	164	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-Rise Multifamily Air Sealing Annual Energy Savings Algorithm	The NYS TRM v10 Air Leakage Sealing measure formula might be a better way to present the calculation	High-rise multifamily is not included for residential measures. The algorithms included in this measure are exclusively for low-rise multifamily or without blower door test. The algorithm which is presented in the NY TRM is used exclusively for high-rise multifamily
91	NJ Utilities Association (NJUA)	2.6.1	165	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-rise Multifamily Air Sealing: table 2-142	Provide source for deemed savings values in table 2-142. Reference link indicates values are based on NY TRM v10, but the values in NY TRM v10 are specific to city locations in NY state.	The source is NY TRM. We used NYC values because of the cities in the NY TRM, NYC is the closest to a statewide NJ approximation. Added a line in the reference to explain this.
92	NJ Utilities Association (NJUA)	2.6.1	166	Residential	Shell	Residential/Low-rise MF Air Sealing	Residential/Low-rise Multifamily Air Sealing: table 2-143	Provide source for deemed savings values in table 2-143. Reference link indicates values are based on NY TRM v10, but the values in NY TRM v10 are specific to city locations in NY state.	The source is NY TRM. We used NYC values because of the cities in the NY TRM, NYC is the closest to a statewide NJ approximation. Added a line in the reference to explain this.
93	NJ Utilities Association (NJUA)	2.7.1	175	Residential	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: table 2-155	Include values 3.41 and 3.34 from peak demand savings equation and provide source in references section.	Updated
94	NJ Utilities Association (NJUA)	2.7.1	175	Residential	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: table 2-155	Value for variable Nppl indicates a GPM value for people. Recommend revising as "2.62" if unknown.	Updated
95	NJ Utilities Association (NJUA)	2.7.3	185	Residential	Water Heating	Storage Tank Water Heater	Storage Water Heater: table 2-167	Value for variable Nppl indicates a GPM value for people. Recommend revising as "2.62" if unknown.	Updated
96	NJ Utilities Association (NJUA)	2.7.6	198	Residential	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators: annual fuel savings formula	include a term (Fgas) in the dTherms calculation to account for the water heater fuel type. Fgas= Fraction of water heaters which are gas = 0.71 Source: From 2015 RECS microdata for Middle Atlantic Div 8. Of 228 households, fuel mix for water heating is 71% gas and 25% electric. No savings are attributed to 4% of households which use other fuel sources.	Updated
97	NJ Utilities Association (NJUA)	2.7.6	199	Residential	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators: table 2-176	correct typo in value for variable Fgas. Update from unkown to unknown.	Corrected

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98	NJ Utilities Association (NJUA)	2.8.2	220	Residential	Whole Building	HPwES	kW savings for HPwES	Many of the approved software tools do not generate hourly outputs, particularly REM/Rate and Snugg Pro, which are popular in this field. This comment requests a simple guidance or algorithm on how to calculate peak demand impacts from these files or acceptance of the method the utilities are using in Tri1. The program is expected to make a very small contribution to total portfolio-wide demand reductions for any utility, so an approximation such as kW to kWh ratios for gas heated vs electricity heated homes or something similar seems appropriate. The utilities agreed for the first Triennium to calc kW by applying an average factor of 0.0006033 kW to kWh saved based on analysis of residential load shapes for non-electric heated homes from May-Sept. The methodology for obtaining this ratio and the final NJ average value programmed into SnuggPro was vetted through our evaluators.	Peak demand algorithms for whole building projects added based on comment.
99	NJ Utilities Association (NJUA)	3	223	C&I	C&I	C&I	Additional C/I Measures for consideration	Consider including additional C&I measures: Elevator Modernization measure (see NY trmv10) Fan destratification (see Illinois TRM) Steam trap repair/replace Future kits may include can of spray foam. Could this (e.g. 12-oz can of spray foam) be addressed in air sealing section, or as stand-alone measure?	*Steam traps - measure added using NY TRM approach with ERS defaults *Elevator & fan destrat - measure added based on NY TRM approach *Spray foam - added to air sealing section
100	NJ Utilities Association (NJUA)	3.1.2-3.1.4	Multiple	C&I	Agriculture	Multiple	Calculation parameters	Different values used for specific heat of milk throughout. Consider revising for consistency	Used 0.93 and updated references
101	NJ Utilities Association (NJUA)	3.1.1	223	C&I	Agriculture	Auto Milker Takeoff	Auto Milker Takeoff: Footnote Sources	Please update reference sources under footnote 60 to match the reference list for this measure.	Corrected
102	NJ Utilities Association (NJUA)	3.1.1	223	C&I	Agriculture	Auto Milker Takeoff	Auto Milker Takeoff:	Could not view V1.2, only V1.1, where it was not clear where the kW/kWh value is derived.	V1.2 accessed using link provided in the TRM. ETDF derived by dividing the retail demand savings (kW) by electric energy savings (kWh)
103	NJ Utilities Association (NJUA)	3.1.5	238	C&I	Agriculture	Livestock Waterer	Table 3-13	Multiple references to table 3-15 should be 3-14. This was a recurring issue in the initial TRM review (often misplaced table references to Peak Factor tables). Consider a review of table references in Calculation Parameters tables.	Corrected
104	NJ Utilities Association (NJUA)	3.1.7	245	C&I	Agriculture	Ventilation Fans	Ventilation Fans:	Multiple issues with dual baseline. There's no approach to estimate kWherep vs kWhnr. Lifetime equation should have EUL - RUL	Updated lifetime section language
105	NJ Utilities Association (NJUA)	3.1.7	247	C&I	Agriculture	Ventilation Fans	Ventilation Fans:	Edit Footnote (ref 66) 'temperature above 50^{o}F	Corrected
106	NJ Utilities Association (NJUA)	3.1.9	256	C&I	Agriculture	Engine Block Heater Timer	Engine Block Heater Timer: W heater, Hrs b, Hrs q, Days, UF	All values citing source 345 originate from a 2015 Wisconsin study with 27 responses. Is it applicable to use an 8yr old study with limited participation for weather-correlated usage values? NYS TRM has similar calculation method with different usage values referencing "Energy Efficiency in New York State Agriculture: Summary of Energy Efficiency Programs and Research Opportunities, NYSERDA, C-4:. Might be worth exploring.	I agree. Changed the values and updated the reference
107	NJ Utilities Association (NJUA)	3.2.1	261	C&I	Appliances	Clothes Washer	Table 3-34	Need an unknown SF for DHW fuel type and Dryer fuel type	DHW fuel type link to appendix, dryer fuel split provided
108	NJ Utilities Association (NJUA)	3.3.2	295	C&I	Appliance Recycling	Room AC Unit Recycling	Room AC Unit Recycling: Calculation Methodology	The calculation methodology was supposed to be updated for this measure, as the Residential measure was, per the IMP for EmPOWER MD.	Updated measure per IMP for EmPOWER MD
109	NJ Utilities Association (NJUA)	3.3.2	295	C&I	Appliance Recycling	Room AC Unit Recycling	Room Air Conditioner: Lifetime Energy Savings Algorithms and Table 3-74	Use Remaining useful life not EUL for Recycling lifetime savings	Updated measure per IMP for EmPOWER MD
110	NJ Utilities Association (NJUA)	3.3.2	296	C&I	Appliance Recycling	Room AC Unit Recycling	Room AC Unit Recycling: Table 3-74, EFLH C	No value stated for EFLH C.	Updated measure per IMP for EmPOWER MD
111	NJ Utilities Association (NJUA)	3.3.2	296	C&I	Appliance Recycling	Room AC Unit Recycling	F_replaced	This value should be based on program design and only if the program induces the replacement. F_replaced = 0 for recycled units picked up from businesses without replacements provided at the same time. The 'Description' refers to a "home". The 'Baseline Condition' is "ERET", meaning the existing equipment is not replaced.	Updated measure per IMP for EmPOWER MD
112	NJ Utilities Association (NJUA)	3.3.2	296	C&I	Appliance Recycling	Room AC Unit Recycling	EFLHc	'Value' field is blank. Is it based on Building Type?	Updated measure per IMP for EmPOWER MD
113	NJ Utilities Association (NJUA)	3.3.3	298	C&I	Appliance Recycling	Dehumidifier Recycling	Dehumidifier Recycling: Table 3-76, Capacity	Provide reference for capacity assumption.	Added reference: Mid-Atlantic TRM

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114	NJ Utilities Association (NJUA)	3.3.3	300	C&I	Appliance Recycling	Dehumidifier Recycling	Dehumidifier Recycling: CF	Update reference number. [372] in table 3-78 on page 300, [372] is not a reference for this section.	Corrected
115	NJ Utilities Association (NJUA)	3.3.3	300	C&I	Appliance Recycling	Dehumidifier Recycling	Table 3-78 Ref	Ref 372 should be 395	Corrected
116	NJ Utilities Association (NJUA)	3.4.2	312	C&I	Foodservice	Holding Cabinets	Holding Cabinets: Table 3-86, Days/year	Appendix D does not explicitly state operating days per year. Should give guidance to calculate or provide values in a table in the measure.	Updated
117	NJ Utilities Association (NJUA)	3.4.2	312	C&I	Foodservice	Holding Cabinets	Holding Cabinets: Table 3-86, Days/year	NJ CEP FY2020 references a table for Hours & Days per building type referencing source 419. Would this be more appropriate? NYS TRM also utilizes a table referencing a report by the California Energy Commission.	Operating days in appendix D are based on the NJ building prototypes. Suggest staying with those values in the interest of consistency with EFLH, etc.
118	NJ Utilities Association (NJUA)	3.4.2	313	C&I	Foodservice	Holding Cabinets	Holding Cabinets: Description	Update full size holding cabinet cubic ft to >/= 13 < 28, per table 3-87, so it aligns with the language in the description section	Corrected
119	NJ Utilities Association (NJUA)	3.4.3	314	C&I	Foodservice	Dishwashers	Dishwashers Annual Electric Savings Algorithm	The Delta_kWh_boosterheater formula is the same as Delta_kWh_waterheater formula? Should be different	Updated
120	NJ Utilities Association (NJUA)	3.4.3	317	C&I	Foodservice	Dishwashers	Dishwasher: Table 3-92, PDF	define PDF value	Corrected
121	NJ Utilities Association (NJUA)	3.4.4	319	C&I	Foodservice	Ice Machines	Ice Machines: Baseline Condition	Prior drafts of this measure had this measure as NR, which has been replaced with DI. Revised measure needs dual baseline for DI. Description should reflect both DI and TOS conditions.	Updated
122	NJ Utilities Association (NJUA)	3.5.1	325	C&I	HVAC	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP: Annual Fuel Savings, Therms b	See Table 3-100, not 3-106.	Corrected
123	NJ Utilities Association (NJUA)	3.5.2	326	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Typo	Pumpsin should be changed to pumps in, found in first sentence under description section.	Corrected
124	NJ Utilities Association (NJUA)	3.5.1	327	C&I	HVAC	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP: OSF	Prior comments address that the savings algorithms indicate the OSF is to be used in all cases, however would likely only apply to certain HP applications. The footnotes explain this, however can foresee how this can be overlooked and cause confusion.	Added the following note: The oversize derating factor (OSF) in the equations above is typically applicable for certain heat pump applications where the heat pump is sized based on heating capacity but is oversized for cooling. A user with a better understanding of site specific conditions can determine whether this factor is applicable or not.
125	NJ Utilities Association (NJUA)	3.5.2	333	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Table 3-104, Baseline Circ Pump	Eff b should be changed to Eff motor b as referred to in 3-107 Calculation Parameters.	Change has been implemented
126	NJ Utilities Association (NJUA)	3.5.2	333	C&I	HVAC	Geothermal and Water Source Heat Pumps	Table 3-107 Calculation Parameter - Update Appendix Link	Update value for "Hrs" - says "Look Up in X"	Corrected
127	NJ Utilities Association (NJUA)	3.5.2	333	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Table 3-107, Hrs	Update look up to correct Appendix, cite source.	Corrected
128	NJ Utilities Association (NJUA)	3.5.2	335	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: ESF/DSF Reference	No source provided for values. Found the values reference the current NJ TRM for VFD 3.7.8, which cites the IL TRM V7 and link provided does not provide access. Could not find mention of values in the IL TRM V7. Please find additional link to source and explicitly state where values can be found.	Values calculated using methodology and parameters laid out in measure - will check math Also double check ESF, DSF in Residential measure
129	NJ Utilities Association (NJUA)	3.5.2	336	C&I	HVAC	Geothermal and Water Source Heat Pumps	Geothermal and Water Source Heat Pumps: Table 3-109, PDF	Update from TBD to Appendix G.	Corrected
130	NJ Utilities Association (NJUA)	3.5.4	336	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Efficient Case Description - Typo	Equipment misspelled	Corrected
131	NJ Utilities Association (NJUA)	3.5.4	336	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Annual Energy Savings Algorithm	Missing kWhq formula?	Meausure is for gas furnaces, unit heaters, and boilers, so no kWh consumption in efficient case. Measure states kWhq = 0.
132	NJ Utilities Association (NJUA)	3.5.3	339	C&I	HVAC	Infrared Heater	Infrared Heater: Table 3-111, HDD55	No reference provided for HDD 55, likely #450 per HDD 65.	Corrected
133	NJ Utilities Association (NJUA)	3.5.3	339	C&I	HVAC	Infrared Heater	Infrared Heater: Table 3-111, EFLH h	No value present or link to table/Appendix for EFLH h.	Corrected
134	NJ Utilities Association (NJUA)	3.5.3	339	C&I	HVAC	Infrared Heater	Infrared Heater: Table 3-111, PDF	PDF not listed in calc parameters table as seen in other measures.	Corrected
135	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Appendix "X"	Baseline efficiency found in Appendix E.	Linked to correct appendix
136	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Typo	Change equipmentif to equipment if in first bullet point explaining dual baselines for early replacement.	Corrected

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137	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: EREP Dual Baselines	Second bullet point - baseline is a code-complaint air source heat pump?	Corrected to "code-compliant unit of same type and size as the installed equipment"
138	NJ Utilities Association (NJUA)	3.5.4	342	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Baseline Efficiencies	Baseline efficiencies match 90.1-2019, except for 2 instances (Steam boiler, gas fired <300 & steam boiler oil fired <300). I believe this is because per 90.1-2019 table 6.8.1-6, those values are only applicable outside US. In that case, what source was used for the values stated in place? Please cite separately if another source was used.	In 90.1 2019, there's a footnote saying "See Informative Appendix F, Table F-4, for U.S. minimum efficiencies for residential products covered by USDOE requirements for U.S. applications" which is what was used for this measure. So essentially the source is the same
139	NJ Utilities Association (NJUA)	3.5.4	343	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Capacity variables	Cap h shown in the algorithms, but Table 4-115 only lists Cap in.	Changed from Cap,h to Cap,in
140	NJ Utilities Association (NJUA)	3.5.4	344	C&I	HVAC	Furnaces, Unit Heaters and Boilers	Furnaces, Unit Heaters and Boilers: Table 3-115, EFLH h	No value present or link to table/Appendix for EFLH h.	Corrected
141	NJ Utilities Association (NJUA)	3.5.5	347	C&I	HVAC	Boiler Controls	Boiler Controls: SF - Cut-Out Controls	Many prior comments regarding this savings factor. Restating that Arkansas TRM specifically states a value of 1.7%, however is used as the source for the 2.2% value, which was scaled per the study referenced. Also the TRM version cited is outdated and was able to track a path for the latest version (https://apsc.arkansas.gov/wp-content/uploads/AR_TRM_V9.1_Volume_1_2_and_3_on_8-31-22.pdf).	Updated number to 1.7 and updated reference
142	NJ Utilities Association (NJUA)	3.5.7	355	C&I	HVAC	Gas Chillers	Gas Chillers: Table 3-127, Cap	There are two variables listed as the same "Cap" with different descriptions and values.	Deleted extra 'Cap' parameter
143	NJ Utilities Association (NJUA)	3.5.7	355	C&I	HVAC	Gas Chillers	Gas Chillers: References	This document needs references for COP b (mentioned above), EFLH, PDF, and measure life variables. Only one reference stated which is vague and not linked to any variable.	EFLH, PDF: found in appendix (methodology/reference explained in appendix) COPb: added reference
144	NJ Utilities Association (NJUA)	3.5.7	355	C&I	HVAC	Gas Chillers	Gas Chillers: References	There is no reference cited for ASHRAE 90.1-2019, used for table 3-128 minimum efficiencies referencing 90.1-2019 6.8.1-3.	Added reference
145	NJ Utilities Association (NJUA)	3.5.8	357	C&I	HVAC	Electric Chillers	Electric Chillers: Table 3-130, EFLH	Table states look up EFLH values in Appendix F, however EFLH are stated in Appendix C.	Corrected
146	NJ Utilities Association (NJUA)	3.5.10	371	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Table 3-149 Calculation Parameters	hrs_h - Delete [125] - duplicate reference not needed.	Corrected
147	NJ Utilities Association (NJUA)	3.5.10	376	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Table 3-154 Peak Factors	Natural gas PDF is not N/A for this measure.	Corrected
148	NJ Utilities Association (NJUA)	3.5.10	376	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Table 3-154 Peak Factors	[123] appears to be incorrect reference.	Updated
149	NJ Utilities Association (NJUA)	3.5.10	376	C&I	HVAC	Heat or Energy Recovery Ventilator	Heat or Energy Recovery Ventilator : Measure Life	[124] appears to be incorrect reference.	Updated
150	NJ Utilities Association (NJUA)	3.5.13	385	C&I	HVAC	EC Motor	Demand Controlled Kitchen Ventilation: PLR Value Reference	PLR values in table 3-162 need a reference source.	It's the Mid Atlantic TRM for both. Added reference
151	NJ Utilities Association (NJUA)	3.5.13	386	C&I	HVAC	EC Motor	Demand Controlled Kitchen Ventilation: References	Table 3-164 needs reference sources.	It's the Mid Atlantic TRM for both. Added reference
152	NJ Utilities Association (NJUA)	3.5.15	397	C&I	HVAC	Guest Room EMS	Guest Room EMS: Measure Life	Should EUL values of common HVAC equipment be presented in the Measure Life section, to be consistent with other measures in the document?	Updated
153	NJ Utilities Association (NJUA)	3.5.16	397	C&I	HVAC	Smart Thermostat	Guest Room EMS: References	Table 3-173 needs reference sources.	Source provided
154	NJ Utilities Association (NJUA)	3.5.17	399	C&I	HVAC	Maintenance	Smart Tstats: SEER/IEER	Has further thought been applied to prior comment: "ADM: Adding "or IEER" seems warranted?JCP&L Vendor: Since eligibility for this measure is up to 25 tons, suggest adding calculation that incorporates IEER for units above 5.4 tons. Current calculation only utilizes SEER, which only applies to units <5.4 tons"	Yes, will update to allow for use of IEER
155	NJ Utilities Association (NJUA)	3.5.16	401	C&I	HVAC	Smart Thermostat	Smart Tstats: Measure Life	Suggest adding a table consistent with other measure. As the host equipment RUL is reference for RF scenarios, suggest adding those values in the table as well.	Updated
156	NJ Utilities Association (NJUA)	3.5.18	409	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Controls: Table 3-180 (Row 7-8)	Reference is inadequate. Calculations for Energy savings factors (SF_ElecCool and SF_ElecHeat) for locations mentioned in TRM are not listed.	Updated
157	NJ Utilities Association (NJUA)	3.5.18	411	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Control: Table 3-181	Space types in Table 3-181 should be updated to match the other tables in this section (e.g. Table 3-182). Also, is 'multi-family exterior' a relevant space type for this measure? Maybe intended to be some kind of parking garage ventilation?	Updated
158	NJ Utilities Association (NJUA)	3.5.18	414	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Control: Table 3-186	Space types in Table 3-186 should be updated to match the other tables in this section (e.g. Table 3-182).	Updated

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159	NJ Utilities Association (NJUA)	3.5.18	414	C&I	HVAC	Advanced Rooftop Controls	Advanced Rooftop Control: Table 3-187	PDF reference should be updated from 'TBD'	Corrected
160	NJ Utilities Association (NJUA)	3.6.1	417	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: Blower door tests	Blower door tests results are not used in energy savings algorithms. Remove text: "Blower door tests shall be performed whenever possible. A blower door test is performed to measure the leakage rate by depressurizing the building to a standard pressure difference of 50 Pascals or 0.2 inches of water. The measured flowrate indicates the leakage rate, or infiltration and exfiltration rate, of the building shell".	Updated
161	NJ Utilities Association (NJUA)	3.6.1	417	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: Home square feet	revise "Home square feet" in table 3-189 to "building square feet"	Corrected
162	NJ Utilities Association (NJUA)	3.6.1	418	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: table 3-190	No source reference provided for values in table 3-190. The link "104" does not match any references.	Updated
163	NJ Utilities Association (NJUA)	3.7.1	418	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Midstream Baseline Wattages, Appendix J	There are two (2) Appendix J in this document, ISR and Midstream Baseline Wattages. Suggest renaming Midstream Baseline to Appendix L.	Corrected
164	NJ Utilities Association (NJUA)	3.6.1	419	C&I	Shell	High-Rise MF Air Sealing	High-Rise Multifamily Air Sealing: table 3-191	Update references in table 3-189 for coincident factor and gas peak day factor to "Lookup in Table 3-191", not in table 3-190	Corrected
165	NJ Utilities Association (NJUA)	3.7.1	421	C&I	Lighting	Lighting Fixtures	LPD_AF and NTG	The LPD_AF is an adjustment factor that reduces the code LPD allowance to account for standard practice. This is not unreasonable, although many jurisdictions use the code baseline as the basis for gross impacts and use NTG to account for standard practice. Not contesting the application of LPD_AF as stated in the protocol but note that both deemed NTG values and NTG studies would need to reflect the LPD_AF term. Since the LPD_AF adjusts for what people would do in the absence of the program, it acts as a free ridership term. Therefore, the NTG table in Appendix H would need to distinguish between new construction and retrofit, and new construction would have higher NTGs. Also, NTG surveys for new construction lighting would need to somehow distinguish that, if a customer states that they would have done all or part of the new const. lighting project without the program, to what extent is that already reflected in the LPD_AF factor.	NMR confirms that NTG (per NMR study) allows for ISP baseline (as opposed to code)
166	NJ Utilities Association (NJUA)	3.7.1	421	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Energy Efficient Wattage	I believe there needs to be clarification regarding the source of the EE wattage used. Manufacturer specs or DLC/Energy Star listings? But efficient condition should not require DLC/ES compliance.	Updated language: "wattage per DLC or ENERGY STAR certification, or manufacturer's cutsheet if certification not required by program"
167	NJ Utilities Association (NJUA)	3.7.1	423	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Table 3-192, HVAC g	Update look up table reference.	Corrected
168	NJ Utilities Association (NJUA)	3.7.1	423	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Table 3-192, EUL	Update EUL reference value in table.	Corrected
169	NJ Utilities Association (NJUA)	3.7.1	424	C&I	Lighting	Lighting Fixtures	Table 3-192 link	HVACg refers to Table 1-8 and is not a link	Corrected
170	NJ Utilities Association (NJUA)	3.7.1	424	C&I	Lighting	Lighting Fixtures	Table 3-192	EUL reference value incomplete	Corrected
171	NJ Utilities Association (NJUA)	3.7.1	425	C&I	Lighting	Lighting Fixtures	Table 3-193 & 3-194	Building Area Method and Space by Space Method were designed for different use-cases by ASHRAE. Consider adding guidance for when to use each table.	Added description
172	NJ Utilities Association (NJUA)	3.7.1	427	C&I	Lighting	Lighting Fixtures	Table 3-196	This method of exterior lighting power calculation has specifics that are not explained in the measure language. Consider adding detail to clarify how the attributes (base site allowance, tradeable vs nontradeable etc) are to be used	Added description
173	NJ Utilities Association (NJUA)	3.7.1	428	C&I	Lighting	Lighting Fixtures	Table 3-197 MF CF	Isn't MF "In-Unit" CF covered in section 2.4.1 Table 2-113? Here it reads 0.59, there = 0.06	Changed to 0.06
174	NJ Utilities Association (NJUA)	3.7.1	428	C&I	Lighting	Lighting Fixtures	Table 3-197	C&I Lighting Fixtures: Operating hours for C&I Lighting for "Museums", "Restaurant - Dine-In" & "Restaurant - Fast food" should be added.	Added
175	NJ Utilities Association (NJUA)	3.7.1	429	C&I	Lighting	Lighting Fixtures	Table 3-198 HVACg for MF	Should we use the "Mid-Stream/Other" row for MF Common Areas? What about MF In-Unit (is that covered in section 2.4.1)?	Added a line in the footnote and a line in the description so that the user doesn't miss this important note

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176	NJ Utilities Association (NJUA)	3.7.1	430	C&I	Lighting	Lighting Fixtures	Lighting Fixtures: Table 3-199	Address prior comment: "If you compare large retrofit oil to large retrofit gas the oil impact is twice as big as gas impact, but for small retrofit its 1/10 as big. Seems odd, double check that these values are correct. Could not find them in any reference." Response indicates using NY TRM which uses blanket -0.002 factor, but do not see any updates made.	Updated to use NY TRM HVACg, consistency throughout TRM checked
177	NJ Utilities Association (NJUA)	3.7.1	430	C&I	Lighting	Lighting Fixtures	Table 3-199 HVACg for MF	Should we use HVACg from the Res section 2.4.1 for MF In-Unit? What about MF Common (rental office vs int hallway)? Please note the units of HVACg_com are different than HVACg_Res.	Updated to use NY TRM HVACg, consistency throughout TRM checked
178	NJ Utilities Association (NJUA)	3.7.1	430	C&I	Lighting	Lighting Fixtures	Table 3-199	Unknown row is off by a factor of 10	Corrected
179	NJ Utilities Association (NJUA)	3.7.2	434	C&I	Lighting	Lighting Controls	Lighting Controls: Annual Fuel Savings	Could the same algorithm be used for the fuel penalty algorithms? Using different algorithms both based on HVAC_g seems incorrect. Because the 0.00073 factor is undefined, its not clear how the Networked Lighting Therms algorithm works, but suspicious that the HVAC_g factor is in numerator in one and denominator in the other.	Updated to use NY TRM HVACg, consistency throughout TRM checked
180	NJ Utilities Association (NJUA)	3.7.2	436	C&I	Lighting	Lighting Controls	Lighting Controls: Measure Life	The algorithms in this chapter, using prescribed savings factors directly, are not suitable for a dual baseline. Lighting controls isn't really suited to a dual baseline and that is not a common industry practice.	Removed dual baseline and updated measure life
181	NJ Utilities Association (NJUA)	3.7.2	436	C&I	Lighting	Lighting Controls	Table 3-205	C&I Lighting Controls: The operating hours for C&I lighting measures is inconsistent throughout the document. Table 3-205 should follow Table 3-197. Table 3-197 was revised based on 1st round of comments.	Updated
182	NJ Utilities Association (NJUA)	3.7.2	437	C&I	Lighting	Lighting Controls	Lighting Controls: Table 3-205	Coincidence Factors for controls savings are not the same as for lighting savings.	**NY TRM**: In Interior Lighting Control measure section, as per Pg 884, "Refer to the CF column of the table in the "Operating Hours" section of the Commercial and Industrial Interior and Exterior Lighting measure for prescribed coincidence factor for commercial indoor lighting measures based on Facility Type." This tells me CF is the same. However, for bi-level control, Parking Lot Lights: 0, Interior: 1 **PA TRM**: Also uses the same CF for both Lighting savings and lighting control savings **Mid Atlantic TRM**: also uses the same CF In conclusion, we propose to use the same CF for both lighting and lighting control measures for this year.
183	NJ Utilities Association (NJUA)	3.7.2	437	C&I	Lighting	Lighting Controls	Lighting Controls: Table 3-205	Table 3-205 (Hrs and CF for Lighting Controls) is almost identical Table 3-197 in the Lighting Chapter. Probably better for consistency purposes to just refer back to that one. Otherwise, there appears to be a typo in the Hospital Hours and CF, and the Warehouse/Small Hours. In both cases the numbers are similar but don't match whereas all the other building types match completely. The Controls table is also missing several of the space types that could be useful including Multi-family.	Updated
184	NJ Utilities Association (NJUA)	3.7.2	438	C&I	Lighting	Lighting Controls	Lighting Controls: Table 3-206, Table 3-207	Tables 3-206 and 3-207 for HVAC interactive factors are also duplicates from the previous chapter - consider just referring back to them.	Updated
185	NJ Utilities Association (NJUA)	3.7.3	443	C&I	Lighting	Delamping	Table 3-212	C&I Delamping: The operating hours for C&I lighting measures is inconsistent throughout the document. Table 3-212 should follow Table 3-197. Table 3-197 was revised based on 1st round of comments.	Updated
186	NJ Utilities Association (NJUA)	3.7.5	451	C&I	Lighting	LED Sign Lighting	LED Sign Lighting: Table 3-223, Hours	Tables references Appendix D for HVAC fan/pump hours, please update with appropriate appendix.	Corrected
187	NJ Utilities Association (NJUA)	3.7.5	451	C&I	Lighting	LED Sign Lighting	Table 3-223	Annual hours of operation (business hours) refers to Appendix D, which lists fan and pump operational hours. This is not relevant to LED signage operational hours, as fans and pumps can cycle on and off (varies by operation and design intent)	Updated
188	NJ Utilities Association (NJUA)	3.7.5	451	C&I	Lighting	LED Sign Lighting	Table 3-223	Missing annual hours of operation assumption references	Updated
189	NJ Utilities Association (NJUA)	3.7.5	452	C&I	Lighting	LED Sign Lighting	LED Sign Lighting: CF Tables and References	Multiple table reference errors throughout the document. Table 3-224 is the correct CF table, not Table 3-43	Updated

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190	NJ Utilities Association (NJUA)	3.7.5	452	C&I	Lighting	LED Sign Lighting	LED Sign Lighting: Table 3-223, Watts b	Per prior comment - baseline for unknown references neon sign, recommend adding values for fluorescent baselines.	NY TRM: Uses the neon sign wattage of 46W PA TRM: uses 45.7 (probably neon baseline) IL TRM: Same neon baseline CA Workpapers: nothing related to fluoroscent baseline Conclusion: I think its a good suggestion. I went through different trms as mentioned above. I also looked at different papers. Typical number for fluoroscent that is almost 610W which seems high to me that I'm not comfortable using. For now, I think we should still to 46W. Also, the TRM currently allows for using site specific values too.
191	NJ Utilities Association (NJUA)	3.7.6	455	C&I	Lighting	Indoor Horitculture LED	PPE_b Value	Indoor Horticulture LED measure calculation is too basic, and may significantly over/under estimate savings, depending on the lighting application. The easiest way to increase the calculation accuracy is to allow for the PPE_b value to vary based on end-use. An example of this can be seen in the Illinois TRM T11 (https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010123_v11.0_Vol_2_C_and_I_092222_FINAL.pdf) - Sec 4.1.11	Added PPE Table from IL TRM
192	NJ Utilities Association (NJUA)	3.7.6	456	C&I	Lighting	Indoor Horitculture LED	Indoor Horticulture LED: Table 3-227	Table only defines one baseline PPE_b value. My understanding is there are different light requirements for growth phases - propagation/vegetative growth/flowering that result in different baseline lighting types and therefore different baseline PPE_b.	Agreed. Addressed in above comment
193	NJ Utilities Association (NJUA)	3.8.2	466	C&I	Motors and Drives	VFD	VFD: Table 3-236, hr	Update appendix for annual run hours.	Updated
194	NJ Utilities Association (NJUA)	3.9.2	475	C&I	Plug Load	Office Equipment	Office Equipment: Table 3-246	The "Source" for each of the office equipment values is "1", it seems this should be "[580]"	Updated
195	NJ Utilities Association (NJUA)	3.9.2	475	C&I	Plug Load	Office Equipment	Office Equipment: Table 3-246	Laser color options have not been included in any of the office equipment categories. This option has more savings associated with it and should be considered as a part of the TRM for printers and multi-function devices.	Spent 30-35 minutes researching and found nothing substantial. Here are my findings: NY TRM: Nothing there Mid Atlantic TRM: Same approach as ours PA TRM: Same approach as ours CT PSD: Also relies on Energy Star IL TRM: Nothing helpful Studies that I looked at are pretty old: 1992, 1996, 1997, 2004 To conclude, we propose stick to the current methodology until a better source for algorithms with different laser colors can be identified.
196	NJ Utilities Association (NJUA)	3.9.2	475	C&I	Plug Load	Office Equipment	Office Equipment: Table 3-246	Default energy savings for "Monitor" in the calculation tool is 8 kWh, the TRM provides 24 kWh as the deemed savings value.	Changed to 8
197	NJ Utilities Association (NJUA)	3.9.3	477	C&I	Plug Load	Smart Strip	Smart Strip: 8760/168	Should consider prior comment accounting for holidays/shutdown days throughout the year. Response to comment acknowledged the merit of the comment, but stated it would consider for the future as offices might vary in terms of shut down days. Couldn't we make the value (8760/168) site specific or default to the current value if unknown?	Replaced (8760/168) with a variable called Wks: Weeks the office is open during the year, to allow for site-specific input
198	NJ Utilities Association (NJUA)	3.9.3	481	C&I	Plug Load	Smart Strip	Smart Strips:	The reference to the source [585] does not seem to be used in the Smart Strips measure. Table 3-251 references [586] and [587].	Updated
199	NJ Utilities Association (NJUA)	3.9.3	481	C&I	Plug Load	Smart Strip	Smart Strips:	The reference [586] is used in this and various other TRMs, but the document does not seem to exist online. Cannot verify any claims made from the results of this source.	Reviewed other TRMs and searched for recent studies, could not find better source
200	NJ Utilities Association (NJUA)	3.9.4	483	C&I	Plug Load	Uninterruptible Power Supply	Uninterrupted Power Supply: Table 3-252	Footnote 124 does not adequate explain how Table 3-252 arrives at the EFLH values. What location and methods are used to determine EFLHs? Are they EFLHs used in equation 124 derived elsewhere in the TRM? How are the EFLHs divided into test load bins of 25% 50% 75% and 100%?	Added the following note: The EFLH values were derived using the following equation EFLH = (t0.25 x 0.25 + t0.5 x 0.5 + t0.75 x 0.75 + t1.0 x 1.0) x 8760 hours. The time spent at specified proportion of reference load (t) was sourced from the ENERGY STAR Uninterruptible Power Supplies Final Version 2.0 Specification document. The 8760 hours assumption is based on the fact that the power is uninterruptible, therefore available year-round, i.e 8760 hours a year.

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201	NJ Utilities Association (NJUA)	3.9.7	491	C&I	Plug Load	Electric Vehicle Chargers	Table 3-260 Calculation Parameters - N_evse	Number of EVSE value in table is N/A, should not be. Should be site specific or deemed	Updated
202	NJ Utilities Association (NJUA)	3.9.7	491	C&I	Plug Load	Electric Vehicle Chargers	Electric Vehicle Charger:	This reference is from nearly a decade ago. At the time, public EVSE saw 7,200 kWh annually. Applying 5.6% savings from upgrading to level 2 charging from level 1 yields a deemed savings of 403 kWh. Is a more updated reference available?	This was the best-available source identified during tech review. Further research recommended.
203	NJ Utilities Association (NJUA)	3.10.5	507	C&I	Refrigeration	Strip Curtains	Strip Curtains: Table 3-280	kWh/ft2 for "Refrigerated Warehouse - Cooler" is calculated 876.37 in the reference but displayed as 153.36 in the TRM.	Updated
204	NJ Utilities Association (NJUA)	3.10.5	508	C&I	Refrigeration	Strip Curtains	Strip Curtains:	Energy Savings for Pre-Existing Curtains values in Table 3-280 are based on a efficacy value or 58%. The source provided for this value suggests an efficacy value of 54.1%. https://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf	Updated
205	NJ Utilities Association (NJUA)	3.10.13	539	C&I	Refrigeration	VFD Compressor	VFD Compressor:	Reference [154] has moved websites. Hyperlink directs to an inactive webpage.	Updated
206	NJ Utilities Association (NJUA)	3.11.1	539	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Delta T amb	Please clarify confusion regarding delta T amb. Many prior comments/responses indicate this value was removed from the calculations, however value is still present. If used, equation needed to calculate the value needs to be added to the measure.	Updated
207	NJ Utilities Association (NJUA)	3.11.1	539	C&I	Water Heating	Storage Tank Water Heater	Description	Paragraph 2 in the Description section seems to have an error, citing eligible storage heaters with both greater than 75 kBTUh and less than 4 kBTUh. Additionally, electric water heaters are described in both kW and BTUh units. Consider revising.	Updated
208	NJ Utilities Association (NJUA)	3.11.1/2/3/5	539	C&I	Water Heating	Multiple	Multiple: Storage Water Heater, Tankless, Heat Pump, and Combination Boiler: Setpoint Temperature	Should there be different setpoint temperatures, if unknown? Storage and Heat Pump Water Heater measures state 140F, where Tankless and Combi measure state 125F.	Updated
209	NJ Utilities Association (NJUA)	3.11.1	541	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Table 3-314, Standy Loss	Units for SL b and SL q should be stated in table.	Updated
210	NJ Utilities Association (NJUA)	3.11.1	541	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Table 3-314, Baseline Thermal Efficiency	Ditto regarding prior comment that existing age and efficiency might be unknown and the measure states if efficiency unknown, use code based on equipment age. This is vague and should be further defined.	Updated to include guidance to assume 2/3 EUL
211	NJ Utilities Association (NJUA)	3.11.1	541	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater:	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
212	NJ Utilities Association (NJUA)	3.11.1	542	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: Table 3-117 PDF	Updated PDF value and reference Appendix G.	Updated
213	NJ Utilities Association (NJUA)	3.11.1	543	C&I	Water Heating	Storage Tank Water Heater	Storage Water Heater: References	A few references cited (223, 229, 336) are not present in the list at the end of the measure. It would be helpful to be able to reference the source without scrolling through the entire document to locate the reference in another measure.	Updated link to references
214	NJ Utilities Association (NJUA)	3.11.2	547	C&I	Water Heating	Tankless Water Heater	Tankless Water Heater: CF Reference	Reference for CF value in Table 3-318 is for measure life, please update to appropriate source.	Updated
215	NJ Utilities Association (NJUA)	3.11.2	551	C&I	Water Heating	Tankless Water Heater	Tankless Water Heater: Table 3-318	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
216	NJ Utilities Association (NJUA)	3.11.3	553	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: Table 3-322, F heat/cool	F heat and F cool values stated in table need reference.	Updated
217	NJ Utilities Association (NJUA)	3.11.3	553	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: Table 3-322	Was there thought put into prior comment regarding constraints of GPD values stated in the table? Comment author suspects stated values are gallons of water, not hot water. Was this investigated? Comment suggests there needs to be a reasonable limit on GPD aligning with the rated capacity of the HPWH.	Source of GPD values does not specify. Good suggestion to limit GPD based on rated capacity of HPWH - updated
218	NJ Utilities Association (NJUA)	3.11.3	553	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: Table 3-322	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
219	NJ Utilities Association (NJUA)	3.11.3	558	C&I	Water Heating	Heat Pump Water Heater	Heat Pump Water Heater: PDF	Update table 3-332PDF value to Appendix G	Updated
220	NJ Utilities Association (NJUA)	3.11.4	560	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Description - MF in-unit	Per prior comment, there should be a note in the measure description addressing the fact that MF in-unit faucets/showerheads can be addressed in the residential protocol.	Updated
221	NJ Utilities Association (NJUA)	3.11.4	561	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: CF	there should be consideration of a CF for electric water heating.	Updated

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222	NJ Utilities Association (NJUA)	3.11.4	561	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Table 3-334, Operating Days/Year	Days fixture used per year should reference table 3-336, not 3-344.	Corrected
223	NJ Utilities Association (NJUA)	3.11.4	562	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Table 3-337	Reference needed for PDF.	PDF linked to appendix
224	NJ Utilities Association (NJUA)	3.11.4	564	C&I	Water Heating	Faucet Aerators and Showerheads	Faucet Aerators and Showerheads: Table 3-336, Operating Days/Year	Source needed for operating days/year based on facility type.	Based on NJ prototype building models, clarification added
225	NJ Utilities Association (NJUA)	3.11.5	564	C&I	Water Heating	Combination Boiler	Combination Boiler: Table 3-339	Per Recirc Pump Control measure, add column in table for reference of each source provided. Match table 3-351	Updated
226	NJ Utilities Association (NJUA)	3.11.6	572	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-343, 8.33	Units for pounds/gal of water. lb/gal	Corrected
227	NJ Utilities Association (NJUA)	3.11.6	572	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-343, Days/year	Look up in table 3-345, not 3-344.	Corrected
228	NJ Utilities Association (NJUA)	3.11.6	573	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-343, Days/year	Reference needed for values	Updated
229	NJ Utilities Association (NJUA)	3.11.6	574	C&I	Water Heating	Pre-Rinse Spray Valves	Pre-Rinse Spray Valves (PRSV): Table 3-347	Reference needed for PDF.	PDF linked to appendix
230	NJ Utilities Association (NJUA)	3.12.1	593	C&I	Process	VSD Air Compressors	VSD Air Compressors	Further research needed per prior comment regarding source of values referencing motors </= to 40HP, while measure includes motors up to 100HP.	Updated to include larger hp range
231	NJ Utilities Association (NJUA)	3.12.2	596	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection: Table 3-367	recommend updating table to match the leakage Rates table (table 6, pg 17) from Chapter 22: Compressed Air Evaluation Protocol from the Uniform Methods Project. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwje6-f_5pD-AhU3HDQIHX8NCd0QFnoECAcQAQ&url=https%3A%2F%2Fwww.nrel.gov%2Fdocs%2Ffy17osti%2F68577.pdf&usg=AOvVaw3zsfwWDE8agqj2JjL5syow	Agree with this comment. Updated reference to the recommended source. The source we initially used is from 2004, while the source they are recommending is from 2013
232	NJ Utilities Association (NJUA)	3.12.2	596	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection	Recommend updating table to match the adjustments factor table (table 5, pg 16) from Chapter 22: Compressed Air Evaluation Protocol from the Uniform Methods Project. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwje6-f_5pD-AhU3HDQIHX8NCd0QFnoECAcQAQ&url=https%3A%2F%2Fwww.nrel.gov%2Fdocs%2Ffy17osti%2F68577.pdf&usg=AOvVaw3zsfwWDE8agqj2JjL5syow	Updated
233	NJ Utilities Association (NJUA)	3.12.2	596	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection:	Unable to find the value in the reference documentation for the electric coincidence factor. The UMP chapter 2 compressed air evaluation protocol does not provide a recommendation for coincidence factor. In the absence of data to backup the 0.846 coincidence factor, recommend using the annual hours divided by 8,760 as the coincidence factor.	Updated
234	NJ Utilities Association (NJUA)	3.12.2	598	C&I	Process	Compressed Air Leak Detection	Compressed Air Leak Detection: References #1	Reference #1 link is an error. Update to: https://www.energystar.gov/sites/default/files/buildings/tools/compressed_air3.pdf	Updated
235	NJ Utilities Association (NJUA)	3.13.1	600	C&I	Whole Building	Combined Heat and Power	Combined Heat and Power:	This measure is currently under revision per comments received on 3/6/2023 on preliminary draft.	Measure will be revised per comments received on draft and added to TRM
236	NJ Utilities Association (NJUA)	5	616	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	DOE-2	Appendix B: Building Prototype Descriptions relies on DOE-2.2 as the energy modeling software. This platform is no longer maintained or updated, and the industry has generally moved to EnergyPlus. We are advising that NJ does the same, or lays a plan to do so for future iterations of the TRM	Agree simulation platform deserves a closer look given industry movement toward EnergyPlus. The SWE has an HVAC full load hour research project planned and we will address this issue when developing the project.
237	NJ Utilities Association (NJUA)	5	616	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	DOE-2	Appendix B indicates that the 2004-05 California DEER study was used to develop the building energy models. The DOE currently maintains up-to-date energy models on the EnergyPlus platform, available in all climate zones and multiple code performances. Consider utilizing these models in the future to ensure model consistency and accuracy. Note: some modification will be required for vintages. https://www.energycodes.gov/prototype-building-models	Agree the DOE prototypes might be a better fit than the updated DEER prototypes. This along with the movement to EnergyPlus will be addressed in a future HVAC full load hour study.
238	NJ Utilities Association (NJUA)	5	616	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototype Descriptions	Appendix B: Building Prototypes	Some of the building prototype models do not seem to have exterior glazing in the renderings (dormitory and large office). Please confirm intent and revise if needed.	All prototypes have exterior glazing defined. Renderings updated to display the exterior glazing.

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239	NJ Utilities Association (NJUA)	6	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C	Heating EFLH for dual-fuel heat pumps likely needed in the future. And would be useful now for program planning and design (e.g. even simply a % of annual heat load provided by fossil fuel vs heat pump)	We have an HVAC full load hour study planned and will investigate compressor and fossil fuel heating FLH data for dual fuel heat pumps.
240	NJ Utilities Association (NJUA)	6.1.1	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-1	Regarding the heating EFLH value for old buildings prior to 1979 for MF Highrise the NY TRM v10 the EFLH lists 513 for buildings built before 1979. The heating EFLH in this table (987) matches the pre-war uninsulated brick building value listed in then Ny TRM v10. Should this be the appropriate value?	Will revert to heating and cooling EFLH from previous NJ protocol for this measure and will ensure EFLH values are consistent throughout residential section. HVAC EFLH will be studied in a future project
241	NJ Utilities Association (NJUA)	6.1.1	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-1	Need weighted averages over 'Home Type' for midstream delivery when participant contact information is not available for surveys (e.g. Point-of-Sale Smart Thermostat discounts).	RECS data used to develop home type weights and weighted averages provided for midstream programs.
242	NJ Utilities Association (NJUA)	6.1.1	647	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-1 Res FLH	Please indicate whether the MF values are only applicable to "In-Unit" (i.e. dwelling unit) hours and MF Common Areas are addressed in the C&I section.	Clarifying language added.
243	NJ Utilities Association (NJUA)	6.1.2	648	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-3 B/T Corr. Example	Please include some MF examples in this table. For instance, MF Rental Office - should we use 'Small Office' or 'Multi-family low-rise'? What about interior hallways (different setpoints than rental office)?	Clarifying language added.
244	NJ Utilities Association (NJUA)	6.1.3	650	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C - Table 6-4	Table 6-4 Auto repair EFLH_h seems high.	Auto repair prototype has large outdoor air fraction driving up the heating full load hours.
245	NJ Utilities Association (NJUA)	6.1.3	651	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-6 MF EFLH	Please add the word "Average" to the middle column of hours ('From 1979 to 2006'), consistent with Table 6-1	Updated
246	NJ Utilities Association (NJUA)	6.1.3	651	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Table 6-6 MF EFLH	Please indicate whether these hours include MF Common Areas. They don't match the hours in the Res table (6-1) leading the reader to assume these are weighted averages.	The Multifamily Highrise prototype includes common areas and can be used for that application.
247	NJ Utilities Association (NJUA)	6.1.3	651	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C: Heating and Cooling EFLH	Appendix C - Table 6-6	Table 6-6 EFLH for highrise MF suggests the assumption is that newer buildings have heating systems that are significantly oversized compared to other building types. Is this correct?	Oversizing assumptions were held constant across the vintages. EFLH is generally lower due to reduced exterior shell to conditioned floor space ratio for multifamily buildings
248	NJ Utilities Association (NJUA)	6 & 7	Multiple	Appendix C (EFLH), Appendix D (hours)	Appendix C (EFLH), Appendix D (hours)	Appendix C (EFLH), Appendix D (hours)	Appendix C & D EFLHs	Appendix D assigns a system fan and pump EFLH by C&I facility type and local climate, while Appendix C uses facility type and HVAC type (no climate consideration). Consider editing one or both of these appendices to be consistent with one another.	Appendix C updated to include EFLH by climate zone
249	NJ Utilities Association (NJUA)	8.1	661	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-1	Is it possible to provide the underlying formulas? A formulaic approach facilitates applications such as tracking and reporting data review and related analysis.	The SEER to SEER2 and HSPF to HSPF2 equivalents were based on a market analysis rather than a calculation. Interpolation of the values or a regression equation based on the tabular data is acceptable.
250	NJ Utilities Association (NJUA)	8.2	661	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Central AC, ASHP, Mini-Splits, PTAC, PTHP: Appendix E - 8-1	No conversions present for EER/EER2.	EER2 to EER conversion guidance added to Appendix E.
251	NJ Utilities Association (NJUA)	8.2	661	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Central AC, Air Source Heat Pump, Mini-Splits, PTAC, PTHP: Appendix E - 8-1	No conversions present for EER/EER2.	EER2 to EER conversion guidance added to Appendix E.
252	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2	2019 Minimum Heating Efficiencies for ASHP > 135,000 Btu/h and < 240,000 Btu/h. Should the 3.2 COP be 3.3 COP? There is a typo in ASHRAE 90.1 2019 that makes it confusing.	Efficiencies reviewed and updated as necessary
253	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2	I can't find EERb referred to in sec 2.3.1 Table 2-60 for units < 65 kBtuh. I also can't find CEERb referred to in the same table.	Efficiencies reviewed and updated as necessary
254	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2	'2013 Minimum Cooling Efficiency' for <65kBtuh Air Source ACs should be 13 SEER instead of 14 SEER.	Efficiencies reviewed and updated as necessary
255	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-2 Sizing missing > = symbol for AC	> 65,000 Btu/h and < 135,000 Btu/h' - SHOULD BE '≥65,000 Btu/h and < 135,000 Btu/h' in the AC table (2nd line of Table 8-2) to capture units that are 65,000 Btu/h	Efficiencies reviewed and updated as necessary
256	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Chiller minimum efficiencies	There are no chillers represented in the minimum efficiencies table, when they are present in the reference tables in ASHRAE 90.1-2019. Consider adding them if minimum chiller efficiencies are used in any TRM calculations.	Efficiencies reviewed and updated as necessary

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257	NJ Utilities Association (NJUA)	8.2	662	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Baseline	table 8-2 requires updates. For example: 2013 CAC baseline was 13 SEER in northern region 2019 was not the year of new standard (e.g. SEER2, HSPF2). Should this say 2023? Should probably separate res split central from commercial since C&I<65kbtu have different standards in 2023 Residential and commercial DHW have different standards not adequately addressed in table 8-5	Efficiencies reviewed and updated as necessary
258	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Hot Water-Gas Fired <300 size 2019 Min Efficiency ASHRAE lists 82%, where is 84% from?	Efficiencies reviewed and updated as necessary
259	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Hot Water-Oil Fired <300 size 2019 Min Efficiency ASHRAE lists 84%, where is 86% from?	Efficiencies reviewed and updated as necessary
260	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam-Gas Fired <300 size 2019 Min Efficiency this appears to be 80% in ASHRAE. Where is 82% from?	Efficiencies reviewed and updated as necessary
261	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam-Gas Fired Natural Draft ≥300 and ≤ 2,500 category under 2013 Min Efficiency 77% appears in ASHRAE 90.1.	Efficiencies reviewed and updated as necessary
262	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam- Gas Fired Natural Draft >2,500 category under 2013 Min Efficiency 77% appears in ASHRAE 90.1.	Efficiencies reviewed and updated as necessary
263	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-3	In Boiler Type Steam-Oil Fired <300 category under 2013 Min Efficiency ASHRAE has 82%. Where is 85% from?	Efficiencies reviewed and updated as necessary
264	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Gas Fired 2013 MIn Efficiency ASHRAE says 78% AFUE or 80% Et. Should Et be included as well?	Efficiencies reviewed and updated as necessary
265	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Oil Fired ASHRAE says 78% AFUE or 80% Et. Should Et be included as well?	Efficiencies reviewed and updated as necessary
266	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Oil Fired 2019 MIn Efficiency which section of code specifies AFUE for nonweatherized mobile homes?	Efficiencies reviewed and updated as necessary
267	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	In Furnace Type Oil Fired 2013 Min Efficiency this is true in ASHRAE 90.1 2013 but it changes in ASHRAE 2019: 80% before 1/1/2023 and 82% after 1/1/2023. It seems odd that the pre 2023 efficiency requirement dropped from 81% to 80% between ASHRAE 2013 and 2019. I'm not sure that this needs to change but I don't know why the newer ASHRAE has different values so I'm mentioning it.	Efficiencies reviewed and updated as necessary
268	NJ Utilities Association (NJUA)	8.2	664	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Appendix E: Code-Compliant Efficiencies	Table 8-4	For Furnace Type Gas Fired, Oil Fired this category is a little confusing. How is it different than the other gas fired and oil fired furnaces? Is this for unit heaters?	Efficiencies reviewed and updated as necessary
269	NJ Utilities Association (NJUA)	9	666	Appendix F: HVAC Interactivity Factors	Appendix F: HVAC Interactivity Factors	Appendix F: HVAC Interactivity Factors	Appendix F	Some measures in the TRM already have interactive factors listed in the specific measure (Pg. 123 Table 2-107). Need clarification on when to use the interactive values in the measures vs. the value in Appendix F, especially if the values conflict.	Efficiencies reviewed and updated as necessary
270	NJ Utilities Association (NJUA)	10	668	Appendix G: Natural Gas Peak Day Factors	Appendix G: Natural Gas Peak Day Factors	Appendix G: Natural Gas Peak Day Factors	Natural Gas Peak Day Factors	Peak day factors: The values for Type 2 look too high in many cases, see table 10-10. Factors in the range of 0.06 mean 6% of total therm use (or EFLH) and savings occur on the peak day. EFLH can't be higher than 24 hours. We did not review all values, but there are definitely issues with some numbers. for example: VAV, high school, central region, pdf is 0.09. that suggests the total annual heating eflh is 24hrs/0.09 = 266.7 EFLH. All heating runtime values (there are no highschool EFLH values in TRM) are much higher than 266. So it's not clear how 0.09 was derived. Regardless, without justification, this any many other values are too high Why should the PDFs be specified in far more detail for gas compared to electric? Many measures have a single electric demand CF, but PDFs are specified by building type AND hvac system AND climate zone. Preferably, the specific factors would be dispersed into the TRM wherever possible or if there's too many of a single measure, then the measure definition should point directly to the relevant table of PDFs in the appendix (i.e.	Issues investigated and revisions made to Appendix G. Weighted average values across climate zones and HVAC types provided.

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
271	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for HPwES Projects	Each individual measure that is part of HPwES projects has its own different NTG value listed in the table; however SnuggPro software may not be able to be modified to apply individual measure NTG values in the software. Is one NTG value for HPwES projects possible if SnuggPro software cannot be modified or it is too costly to modify?	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
272	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H	Suggest eliminating the Unique ID# column, this was used in the NJ CML that will no longer be used once the NJ TRM is updated.	Corrected
273	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H	Define column "PA" or remove	Corrected
274	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Custom	Custom NTG. We suggest one value for custom and do not agree with the assumed rapid commercialization adjustment for any custom measure. If measures are rapidly adopted, they would be well-suited for prescriptive program. Custom projects are inherently unique and therefore the assumption that rapid adoption occurs is not logical.	There should be more than one custom value to represent the assortment of situations. Regarding commercialization, the utilty evaluators may undertake future utility-specific evaluation studies to identify more specific levels.
275	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Residential Retrofit	Do not agree with adjustments (e.g. heat pump increase) for residential retrofit. The default assumption is that the action taken is comprehensive whole-home improvements, and one NTG value would be preferable for the program. It's not advisable to attempt measure-specific NTG values because we would have to de-couple modeled savings to apply the NTG values. If that is the expectation, the TRM should include method to do so.	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
276	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG Residential Direct Install	Residential direct install measure NTG values, especially moderate income, seem relatively low. We'd expect DI to have the highest NTG. Of interest: why is contractor incentive in the NTG list? with NTG =0, is the expectation that the NTG factor may be applied to the cost (there is no savings) in cost/benefit analysis?	The utilities should conduct studies to measure for their own experiences. The hybrid incentive approach accounts for the contractor incentive. That is why the hybrid approach gets a higher NTG than without it.
277	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG QHEC	QHEC Lighting DI measures. NTG is 0.15, 0.08, 0.04 Why are these any different from other QHEC measures? The program removes existing, operating inefficient bulbs meaning the new standard baseline is not relevant until end of RUL. Was that not addressed by update to lifetime hours (AML)? Other QHEC measures also seem relatively low. Pipe wrap or shower thermostatic valve NTG of 0.6 is not logical. We'd expect much closer to 1.0 for these measures	Because lighting is facing federal standard change, and if the custom kept them in place, they would likely burn out and replace with an LED. The utilities should conduct studies to measure for their own experiences.
278	NJ Utilities Association (NJUA)	11	682	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: NTG Building Improvements	What does "Building Improvements" include? Or what does it not include? It does not have a value for Electric NTG	Building improvements is the term used in the coordinated measure list. We assume it is mostly building shell measures. The literature did not support an electric-specific improvements estimate, so the utilites should default to "custom - other" for electric.
279	NJ Utilities Association (NJUA)	12	766	Appendix I: Realization Rates	Appendix I: Realization Rates	Appendix I: Realization Rates	Appendix I - Realization Rates	There are many versions of kits which have different measures and different delivery mechanisms. We will suggest removing kits from RR table. ISR and fuel type % assumption are the key parameters, RR is unnecessary.	Realization rates reviewed and updated based on supporting data received.
280	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J ISR	Missing measure ISR's: Advanced Power Strips, QHEC, SJG Pipe Insulation, QHEC, ETG and SJG	ISR terms added to equations as needed.
281	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J ISR	Aerator bathroom QHEC ETG listed twice.	Corrected
282	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J ISR	Aerator kitchen QHEC ETG listed twice with different values. 1.0 matches ADM's report.	Corrected to 1.0
283	NJ Utilities Association (NJUA)	13	772	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J: In-Service Rates	Appendix J	ISRs in the table came from evaluation. If measures are not provided in this table, should we use the ISR in the measure? Guidance needs added to each measure to explain when to use the ISR listed in the measure vs. when to use the ISR in Appendix J.	Guiding language added

Comment No.	Commenter	Section #	Page	Market	End-Use	Measure	Topic / Item	Comment	Comment Reponse
284	NJ Utilities Association (NJUA)	14	776	Appendix K: DHW and Space Heat Fuel Split	Appendix K: DHW and Space Heat Fuel Split	Appendix K: DHW and Space Heat Fuel Split	Appendix K	Appendix K is not mentioned in any of the measures in the TRM. Is clarification needed on when to use default values in the measure and when to use the value in Appendix K? And if a measure is missing from Appendix K, do all the individual measures have default or unknown values to use?	Fuel factor should be used in lieu of default values where listed. Default values added where missing
285	NJ Utilities Association (NJUA)	15	778	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Appendix Name	The letter should be L instead if J	Corrected
286	NJ Utilities Association (NJUA)	15.2	783	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Appendix K: Lighting Wattages	Formatting	Need a page break before this section starts	Corrected
287	NJ Utilities Association (NJUA)	General	global	General	General	General	TMY data	TMY3 data is referenced for use throughout. The industry is moving towards TMYx, so it may be wise to update at this time. This will allow for more accurate savings calculations relative to current climate conditions.	Movement to TMYx will be investigated as part of heating and cooling full load hour update project
288	NJ Utilities Association (NJUA)	General	global	General	General	General	Naming convention	Throughout the TRM document, Energy Star is depicted in a number of different ways: EnergyStar, ENERGYSTAR, Energy Star, ENERGY STAR etc. Consider updating for consistency.	Updated to ENERGY STAR throughout
289	Aeroseal	2.3.6		Residential	HVAC	Duct Sealing and	Use of site specific results	Aeroseal requested inclusion of a savings algorithm based on test in/ test out duct leakage data.	Measure calculations accomdate test in / test out duct leakage measurements.
290	Aeroseal	3.5.xx		C&I	HVAC	Duct Sealing and	Add the measure	Aeroseal requested a C&I duct sealing measure based on test in / test out duct sealing results	C&I duct sealing measure added
291	Dandelion Energy	2.3.2		Residential	HVAC	Ground Loop and	EFLH	Dandelion energy requested a revision to the heating and cooling full load hour data	An HVAC heating and cooling full load hour study is planned as part of the SWE overall evaluation plan.
292	Honeywell	General		Appendix H: Net-to-Gross Factors	General	General	Net to gross ratios	Honeywell requested removal of NTG appendix from TRM	Addressed as a policy issue in the comment response
293	Honeywell	3.12.1		C&I	Whole Building	bined Heat and P	Add emission factors	Honeywell requested adding emission factors	Emission factors included in the CHP section
294	Honeywell	1.8		General	General	General	Baselines for early replacement projects	Honeywell requested coverage of early replacement projects using existing equipment baselines	Early replacement (EREP) baseline included in the introduction and applicable measure sections.
295	MaGrann	2.1.10		Residential	HVAC	om Air Condition	Equation error	MaGrann requested an change to the Room AC with central controls savings algorithm	Change has been implemented
296	MaGrann	2.8.3		Residential	Whole Building	New Construction	EnergyStar version numbers	MaGrann requesed removing references to a specific EnergyStar specification version	EnergyStar specification numbers will be updated as needed during the TRM annual review process.
297	Recurve	3.13.4		C&I	Whole Building	Custom	Inclusion of OpenEEMeter platform	Recurve requested addition of the OpenEEMeter platform to the C&I custom measure description	OpenEEMeter is an implemenation of the IPMVP Option C M&V protocol which is already covered in the C&I Custom section. Language added to clarify
298	Recurve	2.8.x		Residential	Whole Building	Custom	Add measure	Recurve requested addition of the OpenEEMeter platform as a residential measure	Measure section added
299	NJ Business & Industry Assn (NJBIA)	General		Appendix H: Net-to-Gross Factors	General	General	Net to gross ratios	NJ Business & Industry Assn (NJBIA) requested removal of NTG appendix from TRM	Addressed as a policy issue in the comment response
300	NJ Large Energy Users Coalition	General		Appendix H: Net-to-Gross Factors	General	General	Net to gross ratios	NJ Large Energy Users Coalition requested removal of NTG appendix from TRM	Addressed as a policy issue in the comment response
301	Uplight	2.8.1		Residential	Whole Building	Behavioral	Missing document	Uplight requested access to the Behavioral Guideline document	Behavioral Guideline available on the BPU website
302	Uplight	General		General	Whole Building	Demand response	Add measure	Uplight requested additional guidance on demand response program requirements	Demand response guidelines not in TRM scope. Guidance will be provided separately.
303	PSE&G	1.9		General	General	General	Peak demand definition	PSEG requested edits to the peak demand section and clarification that TRM coincidence factors may not conform to PJM peak demand definitioin	Language added
304	Nj Division of Rate Counsel	Appendix H: Net-to-Gross Factors		General	General	General	Net to gross ratios	NJ Division of Rate Counsel requests modifiction to Appendix H Net to Gross factors	Addressed as a policy issue in the comment response
305	JCP&L	Appendix I: Realization Rates		General	General	General	Remove Appendix I	JCPL requests removal of Appendix I	Addressed as a policy issue in the comment response
306	PSE&G	Appendix I: Realization Rates		General	General	General	Revise Appendix I	PSEG provided evidence to support updates to Appendix I	Evidence reviewed and updates made
307	South Jersey Industries	Appendix I: Realization Rates		General	General	General	Remove Appendix I	SJG and ETG request removal of Appendix I	Addressed as a policy issue in the comment response
308	South Jersey Industries	Appendix I: Realization Rates		General	General	General	Revise Appendix I	SJG and ETG provided evidence to support updates to Appendix I	Evidence reviewed and updates made
309	New Jersey Natural Gas	Appendix H: Net-to-Gross Factors		General	General	General	Net to gross ratios	NJNG requests removal of Appendix H Net to Gross factors	Addressed as a policy issue in the comment response

Commenter	Market	End-Use	Measure	Topic / Item	Comment Summary	Response
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for HPwES Projects	Each individual measure that is part of HPwES projects has its own different NTG value listed in the table; however SnuggPro software may not be able to be modified to apply individual measure NTG values in the software. Is one NTG value for HPwES projects possible if SnuggPro software cannot be modified or it is too costly to modify?	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Custom	Regarding custom NTG, suggest one value for custom and do not agree with the assumed rapid commercialization adjustment for any custom measure. If measures are rapidly adopted, they would be well-suited for prescriptive program. Custom projects are inherently unique and therefore the assumption that rapid adoption occurs is not logical.	There should be more than one custom value to represent the assortment of situations. Regarding commercialization, the utilty evaluators may undertake future utility-specific evaluation studies to identify more specific levels.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG for Residential Retrofit	Do not agree with adjustments (e.g. heat pump increase) for residential retrofit. The default assumption is that the action taken is comprehensive whole-home improvements, and one NTG value would be preferable for the program. It's not advisable to attempt measure-specific NTG values because we would have to de-couple modeled savings to apply the NTG values. If that is the expectation, the TRM should include method to do so.	The utility evalutors should be able to use utility-specific expected savings to develop a weighed average NTG for the program. Alternatively, this can be done across all utilities, but we would need access to the expected savings per measure to develop a weighted average.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG Residential Direct Install	Residential direct install measure NTG values, especially moderate income, seem relatively low. We'd expect DI to have the highest NTG. Of interest: why is contractor incentive in the NTG list? with NTG =0, is the expectation that the NTG factor may be applied to the cost (there is no savings) in cost/benefit analysis?	The utilities should conduct studies to measure for their own experiences. They hybrid incentive approach accounts for the contractor incentive. That is why the hybrid approach gets a higher NTG than without it.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H - NTG QHEC	QHEC Lighting DI measures. NTG is 0.15, 0.08, 0.04. Why are these any different from other QHEC measures? The program removes existing, operating inefficient bulbs meaning the new standard baseline is not relevant until end of RUL. Was that not addressed by update to lifetime hours (AML)? Other QHEC measures also seem relatively low. Pipe wrap or shower thermostatic valve NTG of 0.6 is not logical. We'd expect much closer to 1.0 for these measures.	Because lighting is facing federal standard change, and if the custom kept them in place, they would likely burn out and replace with an LED. The utilities should conduct studies to measure for their own experiences.
NJ Utilities Association (NJUA)	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: Net-to-Gross Factors	Appendix H: NTG Building Improvements	What does "Building Improvements" include? Or what does it not include? It does not have a value for Electric NTG	Building improvements is the term used in the coordinated measure list. We assume it is mostly building shell measures. The literature did not support an electric-specific improvements estimate, so the utilites should default to "custom - other" for electric.

Attachment F

New Jersey Cost Test

Triennium 2

New Jersey Board of Public Utilities
Division of Clean Energy
44 S. Clinton Ave.
Trenton, NJ 08625

Introduction

The Clean Energy Act of 2018[1] ("CEA" or "the Act") included requirements to increase the energy savings enjoyed by New Jersey consumers through a new generation of efficiency ("EE") and peak demand reduction ("PDR") programs. Key to the legislation was the concept that the Board of Public Utilities ("Board" or "BPU") shall "ensure investment in *cost-effective* energy efficiency measures," while also ensuring "universal access to energy efficiency measures" and serving "the needs of low-income communities . . . ." (emphasis added). This summary describes the primary benefit-cost test for the second three years ("Triennium 2") of EE and PDR investments in New Jersey that is designed to carefully steward ratepayer dollars by ensuring that these investments are cost-effective, while also ensuring universal access and serving the needs of low-income communities. The CEA requires that:

> *The energy efficiency programs and peak demand reduction programs shall have a benefit-to-cost ratio greater than or equal to 1.0 at the portfolio level, considering both economic and environmental factors, and shall be subject to review during the stakeholder process established by the board pursuant to subsection f. of this section. The methodology, assumptions, and data used to perform the benefit-to-cost analysis shall be based upon publicly available sources and shall be subject to stakeholder review and comment. A program may have a benefit-to-cost ratio of less than 1.0 but may be appropriate to include within the portfolio if implementation of the program is in the public interest, including, but not limited to, benefitting low-income customers or promoting emerging energy efficiency technologies.*[2]

The Act specifically requires that each portfolio of EE and PDR programs must have a benefit-to-cost ratio ("BCR") greater than or equal to 1.0, which means that the portfolio yields positive net benefits (i.e., benefits less costs) to the New Jersey economy and is therefore "cost-effective." The Act allows (and in fact, for the purposes of serving low-income communities or ensuring universal access to EE, requires) that every program may not meet this cost-effectiveness standard. However, reasonable policy interests should support the adoption of programs with BCRs below 1.0, as their inclusion in a portfolio will reduce overall net benefits achieved. Similarly, individual efficiency measures do not need to be cost-effective, although the cost-effectiveness of individual measures may be considered during the review of program filings. As with programs, non-cost-effective measures should typically only be included for good reason, such as to promote health and safety, to ensure equitable access, or to spur innovation, the adoption of other measures, or longer-term market transformation.

While the CEA is not explicit in prescribing a cost-effectiveness test beyond requiring the inclusion of economic and environmental factors, it is clear that such a test is needed to achieve the purpose of the state's EE and PDR programs serve the public interest of all New Jersey residents. As such, the primary cost-effectiveness test used to evaluate these programs should reflect the impacts of the programs on the state's overall economy and environment, including not only energy but also non-energy benefits that EE and PDR programs can provide to the residents of New Jersey. This summary outlines the primary cost test for New Jersey's EE and

[1] P.L. 2018, c. 17 (N.J.S.A. 48:3-87.8 et al.).

[2] N.J.S.A. 48:3-87.9(d)(2).

PDR programs, including the costs, benefits, sources for such inputs, and guidelines for the use of the test.

Executive Summary

New Jersey has historically used five standard benefit-cost tests to evaluate the costs and benefits of EE programs: the Total Resource Cost Test ("TRC"), Societal Cost Test ("SCT"), Program Administrator Cost Test ("PACT"), Participant Cost Test ("PCT"), and Ratepayer Impact Measure Test ("RIM"), which are described in more detail in the "Background" section below.

In order to implement the CEA's requirement that EE and PDR portfolios have BCRs greater than or equal to 1.0, all program administrators shall use a primary benefit-cost test. BPU staff ("Staff") worked with stakeholders to design an initial New Jersey Cost Test ("NJCT") to fulfill the CEA's requirements to consider economic and environmental factors, ensure universal access to EE, and serve the needs of low-income communities.[3] It was anticipated that the Triennium 1 NJCT, which applied to the first three-year term of EE and PDR programs,[4] would evolve over time through the efforts of the EM&V Working Group ("EM&V WG") and could include additional or different impacts as they are studied further and evaluated for use in New Jersey.

In considering which impacts to include in the Triennium 1 NJCT, Staff used the TRC as a foundation and added inputs, including non-energy impacts ("NEIs"), that are both relevant to New Jersey's policy goals and can be applied based on readily available research and industry consensus. Staff also identified near-term and potential long-term sources for the values for each cost and benefit included in the NJCT.

In preparation for Triennium 2, Staff worked with the Statewide Evaluator ("SWE"), EM&V WG, and NJCT Committee to discuss potential revisions to the NJCT. After soliciting and reviewing comments from public stakeholders about the proposed NJCT, Staff prepared final recommendations to the Board for the NJCT that will apply for Triennium 2. As adopted by the Board, the Triennium 2 NJCT shall be used by all program administrators for the second program cycle and will be reviewed by the SWE, EM&V WG, NJCT Committee, and public stakeholders for potential future updates. Table 1 summarizes the various inputs and methodologies that it is expected program administrators will follow in Triennium 2. Please note that the NJCT WG discussed possible inclusion of Avoided $PM_{2.5}$ emissions, Avoided Volatility Cost, Avoided RPS Costs, Economic Development, and Avoided Natural Gas T&D in the NJCT, but it was ultimately decided by BPU staff to conduct further research into these benefits before Triennium 3.

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[3] *See* In re the Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO19010040 (Order dated June 10, 2020) ("June 10, 2020 Order"), p. 3.

[4] Each program year will commence on July 1 and end on June 30 of the following year, in alignment with State fiscal years. The second three-year term will include Program Year 4 (July 1, 2024 – June 30, 2025), Program Year 5 (July 1, 2025 – June 30, 2026), and Program Year 6 (July 1, 2026 – June 30, 2027).

Table 1: Summary of New Jersey Cost Test Inputs and Values

	Input	Description	Calculation method or value
Utility System Costs	Measure incremental costs	Total costs associated with the efficiency measure implemented (i.e., material and labor) less the costs of the baseline measure	Monetized
	Program administration costs	Non-measure costs, including program-specific (such as overhead, marketing, and data tracking costs) and non-program-specific costs (such as administration and planning; and evaluation, monitoring, and verification costs)	Monetized
Utility System Benefits	Avoided wholesale electric energy costs	Value of electric energy directly avoided by reductions in energy consumption.	Calculated using the zonal or Western Hub forwards for up to 5 years and then inflated with EIA AEO in years 6+.
	Avoided wholesale electric capacity costs	Value of electric capacity directly avoided by reductions in electric consumption.	Calculated by multiplying the demand offered into, and cleared in, the PJM Reliability Pricing Model ("RPM") by the relevant zonal clearing price in the Base Residual Auction using the actual clearing price, as appropriate, or a three-year rolling average
	Avoided wholesale electric transmission and distribution capacity costs	Value of future transmission and distribution capacity costs avoided by reductions in electric consumption	Avoided transmission costs are calculated by using the most recent Network Integration Transmission Service ("NITS") Rate as applicable to individual utility service territories. Avoided distribution costs are calculated by determining the total annual distribution charges that the customer would have paid before its participation in the program and then subtracting the total distribution charges the customer paid after the implementation of the EE measures.
	Avoided wholesale electric ancillary costs	Value of avoided electric ancillary services (e.g., spinning reserves, frequency regulation, black start capability, reactive power, etc.)	Calculated using a three-year rolling average of PJM Market Monitor prices.

		required for safe and effective grid operation	
	Avoided wholesale natural gas supply costs	Value of natural gas supply costs avoided by reductions in natural gas consumption	Calculated using NYMEX futures contracts plus delivery basis
	Avoided delivered fuel costs	Avoided costs of delivered fuels such as propane or fuel oil	Calculated using a three-year rolling average of historic EIA NJ residential fuel oil and propane prices escalated using an annual growth rate derived from Annual Energy Outlook projections
	Electric energy demand reduction induced price effects ("DRIPE")	Value of price effects resulting from reduced demand in the electric energy market	Included as an adder calculated as 5% of the avoided wholesale electric energy costs
	Electric capacity DRIPE	Value of price effects resulting from reduced demand in the electric capacity market	Included as an adder calculated as 5% of the avoided wholesale electric capacity costs
	Natural Gas DRIPE	Value of lower natural gas costs due to wholesale natural gas market price suppression from diminished demand	Included as an adder calculated as 5% of the avoided wholesale natural gas supply cost
Non-Energy Impacts	Avoided emissions impacts	Carbon dioxide (CO_2): Avoided damages for each ton of CO_2 avoided SO_2 and NO_x: Avoided damages for each ton of SO_2 and NO avoided	CO_2: Calculated for electric and natural gas using the 3% discount rate "Annual SC-CO_2," adjusted for today's dollars, as published in the most recent Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis by the Interagency Working Group on Social Cost of Greenhouse Gases; PJM emission rates Other emissions: calculated for electric and natural gas using the average of the high case and low case estimates from the EPA report (updated in January 2022) entitled *Estimating the Benefit per Ton of Reducing Directly-Emitted PM2.5, PM2.5 Precursors and Ozone Precursors from 21 Sectors*; PJM emission rates
	Low-income benefits	Adder applied to account for additional benefits (including health and safety) to low-income participants and community	30% (15% NEB + 15% additional LI) applied to avoided wholesale energy costs.

	Non-energy benefits	Adder applied to all non-low-income programs to account for non-energy benefits not already included in the NJCT that are difficult to quantify (including public health, water and sewer benefits, economic development, etc.)	15% applied to avoided wholesale energy costs.
Global Inputs	Discount rate	Interest rate that calculates the present value of expected yearly benefits and costs	3% real
	Electric line losses	Electric marginal line losses, using approved line loss factor in utility's tariff	Utility-specific line loss factor grossed up for marginal losses by 1.5
	Natural gas losses	Natural gas marginal losses, using approved losses factor in utility's tariff	Utility-specific loss factor

Background

New Jersey has historically used five standard cost-effectiveness tests, based on the California Standard Practice Manual ("CSPM"),[5] to review the costs and benefits of EE programs. More specifically, the BPU's Division of Clean Energy ("DCE") has required New Jersey's electric and gas public utilities to evaluate their EE programs using the five tests. The DCE has also used the five tests to evaluate New Jersey Clean Energy Program ("NJCEP") offerings, which in turn use avoided cost assumptions developed by the Rutgers Center for Green Building ("RCGB").[6]

These five basic cost-effectiveness tests, as defined below by the CSPM, reflect varying perspectives and include different costs and benefits. Of the jurisdictions that have a primary test, many leading states rely on the SCT or a modified TRC, both of which consider costs and benefits from the entire jurisdiction's economy.

- **Total Resource Cost Test ("TRC")** and **Societal Cost Test ("SCT")**: The TRC measures the combined impacts of a resource option based on the total costs and benefits of the program, including for the participants and the utility. The SCT is a variant of the TRC. It

[5] California Public Utilities Commission, "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects" (October 2001), *available at* https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf. As noted on page 6 of the manual, the tests are not intended to be used individually or in isolation. Rather, the manual suggests that the results of tests must compared and that there are tradeoffs between the various tests. The manual provides a description of the strengths and weaknesses of each test to assist users in qualitatively weighing test results.

[6] *See*, *for example, Energy Efficiency Cost-Benefit Analysis Avoided Cost Assumptions Technical Memo: May 1, 2019 Update* ("2019 RCGB Avoided Cost Memo"). For a list of recent RCGB Avoided Cost Memos, *see* https://njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/market-analysis-baseline-studies/market-an

goes beyond the TRC in that it attempts to quantify the change in the total resource costs to society as a whole rather than to only the service territory (the utility and its ratepayers). The SCT uses essentially the same input variables as the TRC test, but they are defined with a broader societal point of view. For example, the SCT includes the effects of externalities (e.g., environmental, national security), excludes tax credit benefits, and applies a social discount rate. As noted in the CSPM, traditionally, implementing agencies have independently determined the details of the SCT, such as the components of the externalities, the externality values, and the policy rules that specify the contexts in which the externalities and tests are used.

- **Program Administrator Cost Test ("PACT")**[7]: The PACT measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant.
- **Participant Cost Test ("PCT")**: The PCT measures quantifiable benefits and costs to the customer due to participation in a program. As noted in the CSPM, since many customers do not base their decision to participate in a program entirely on quantifiable benefits, this test cannot be a complete measure of the benefits and costs of a program to a customer.
- **Ratepayer Impact Measure Test ("RIM")**: The RIM measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after program implementation are less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer bills or rate levels.

There are also other methods for developing primary cost tests, such as through the methods described in the National Standard Practice Manual ("NSPM"). The NSPM method results in a state-specific test, referred to as a Resource Value Test ("RVT"), that is based on a jurisdiction's articulated policy and other objectives.

New Jersey Cost Test Framework

The NJCT is the State's primary test for determining cost-effectiveness of EE and PDR programs, to be used in plan development, approval, and evaluation assessments. The NJCT shall be used to determine compliance with the CEA's 1.0 BCR requirement. The NJCT has been designed to include all costs and benefits relevant to a proposed portfolio of EE programs that are reasonably quantifiable or otherwise important considerations and that align with the policies

[7] It is also referred to as the "utility cost test" ("UCT"); however, PACT is preferred because program administrators may not always be utilities, and it is reasonable to consider the entire costs and benefits on both gas and electric systems (which may reflect different utilities) when programs are addressing both fuels.

articulated in the CEA, as well as additional public interest goals of the BPU and the State of New Jersey.

As adopted by the Board, program administrators will use the NJCT as the primary cost-effectiveness test. In addition to the NJCT, the results of the existing TRC, SCT, PACT, PCT, and RIM will be reported for informational purposes.

Efficiency programs can provide additional benefits to society beyond the ratepayer cost savings directly resulting from using less energy. Including appropriate NEIs to adequately capture the full range of impacts that these programs have on participants and society helps to ensure that benefit-cost screening is balanced and symmetrical. Given the requirements of the CEA and the participant and societal benefits provided by EE programs, the NJCT includes NEIs.

The SWE, EM&V WG, and NJCT Committee will review the overall NJCT framework on an ongoing basis and consider modifications in collaboration with Staff. In addition, the Board has tasked the EM&V WG with developing a process for all EE and PDR programs through which the methodologies for developing the value of relevant costs and benefits are appropriately updated and memorialized ahead of each program cycle and/or as needed. All NJCT changes will be adopted by the Board before being considered final.

The methods and policies used to administer the NJCT shall be consistent across all program administrators. Inputs should be established according to the process described above prior to each three-year program cycle and for retrospective evaluation of program performance related to a given cycle. In addition, most input values should reflect average statewide estimates, rather than be utility-specific. This will ensure fair comparisons of all BCA results across program administrators and for statewide co-managed and BPU-administered programs. However, utility-specific values may be used for certain inputs where deemed appropriate by the Board and where the use of such values is in keeping with the CEA's requirement that input values be publicly available.[8]

Global NJCT Inputs

Most of the key inputs for conducting the NJCT are variable and measure-, program-, or portfolio-specific, such as the actual stream of annual costs and savings. Others are consistent statewide ("global") but updated with each three-year EE and PDR program cycle. This section outlines the key global inputs or methods used by the NJCT.

Discount Rate

EE measures typically have relatively high upfront costs that need to be recovered by savings over the life of the measure. Benefit-cost analyses for programs or projects with streams of costs or benefits over more than one to two years use the standard accounting practice of discounting the value of future benefits and costs using discount rate to calculate the present value of expected yearly benefits and costs. Discounting is especially important when

[8] N.J.S.A. 48:3-87.9(d)(2).

comparing projects or programs with different lifespans. Discounting to a present value therefore allows a more apples-to-apples comparison of projects with various lifespans.

As explained by the Office of Management and Budget ("OMB") in Circular A-94, "[the] higher the discount rate, the lower is the present value of future cash flows."[9] For example, as described in EPA *Guidelines for Preparing Economic Analyses*, if the benefits of a given program occur 30 years in the future and are valued in real terms at $5 billion at that time, the rate at which the $5 billion in future benefits is discounted can dramatically alter the economic assessment of the policy. $5 billion 30 years in the future discounted at 1% is $3.71 billion, at 3% it is worth $2.06 billion, at 7% it is worth $657 million, and at 10% it is worth $287 million.[10]

Many other states that promote EE programs, especially utility-administered programs, use the utility weighted-average cost of capital ("WACC") as the discount rate, although several states have employed lower discount rates. OMB Circular A-94 indicates that a real discount rate of 7% should be used as a base-case for regulatory analysis, as that rate approximates the marginal pretax rate of return on an average investment in the private sector, and that a rate higher than 7% should be used if the "main cost is to reduce business investment."[11] OMB also states that a lower discount rate is appropriate "when regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services)."[12] The lower rate that is most often used to reflect the "social rate of time preference" is the rate at which "society" discounts future consumption flows to their present value, which can be estimated according to the real rate of return on long-term government debt.[13]

The Board has traditionally used a nominal discount rate of 7% for all five CSPM tests applied to EE programs. The Triennium 2 NJCT will continue to use a 3% real discount rate to align with public policy in the state and account for how implementation of the EE programs will significantly and directly affect private consumption (e.g., reduce energy consumption by utility customers), as well as result in costs and benefits that impact not only utilities and program participants but New Jersey ratepayers, residents, and society at large over many years.

Line Losses

Due to electric line losses, a kWh saved from efficiency at site translates to more than one kWh saved at generation. The higher the load on the electric system, the higher the line losses. This

[9] U.S. Office of Management and Budget, *Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992) at 8, *available at* https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A94/a094.pdf.

[10] U.S. Environmental Protection Agency, *Guidelines for Preparing Economic Analyses* (2016) at 75.

[11] U.S. Office of Management and Budget, *Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992) at 9.

[12] U.S. Office of Management and Budget, *Circular A-4* (September 17, 2003), *available at* https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4.

[13] Id.

means that the line losses from energy saved through efficiency, which saves energy at the margin, are significantly higher than average system losses.

Electric line losses are calculated by using the average line loss factor in each electric utility's tariff. A factor of 1.5 is used to convert average line losses to marginal line losses.

Natural gas losses are calculated by using the losses factor in each natural gas utility's tariff.

Consideration of a multiplier for converting average energy losses to marginal losses during times of peak demand may be explored in the next update to the NJCT.

Costs

Efficiency Measure Incremental Costs

Efficiency measure incremental costs are the total costs (to the utility, installer, participant, etc.) associated with the efficiency measure implemented (i.e., material and labor) less the costs of the baseline measure. Specific values for measure incremental costs were recently determined in a literature review study from DNV[14] and should be used for the NJCT calculations. Going forward, a Phase II IMC Study, that will include primary research for New Jersey, may be conducted. To the extent results from the Phase II IMC Study are available prior to program filings for Triennium 2, these results should also be used.

Currently, equipment operation and maintenance ("O&M"), are not explicitly defined in the Incremental Measure Cost study data described above. As estimates or actual values are developed for New Jersey using primary research, they may be documented and incorporated more explicitly in the NJCT.

Program Administration Costs

Staff recommends including all non-measure program costs (i.e., those costs that do not directly cover some portion of the incremental measure costs) in overall portfolio level cost-effectiveness. Non-measure costs can generally be divided into two broad categories: non-measure program-specific costs and non-program-specific costs.

Non-Measure Program Costs

Non-measure specific program costs include those costs attributable to specific programs but not individual measures. Such costs may include, but are not limited to, overhead, marketing, and data tracking costs.

Non-Measure, Non-Program-Specific Costs

Non-program specific costs include, but are not limited to, non-program-specific administration, planning and analysis, EM&V, and regulatory costs. Non-program costs

[14] Energy Efficiency Triennium 2 Incremental Measure Cost Values (2023): https://njcleanenergy.com/files/file/BPU/2023/Energy%20Efficiency%20Triennium%202%20Incremental%20Measurement%20Costs%20Values%20(2023).xlsx

that are not able to be reasonably allocated or assigned to a specific program should only be included at the portfolio level.

Benefits

Energy Savings

EE investments provide two main types of energy savings that need to be quantified in any cost-benefit analysis. First, program participants enjoy *direct* savings associated with lower utility bills when they consume less electricity or other forms of energy. Second, New Jersey residents may benefit from *indirect* savings because of the reduced generation and transmissions costs that result when energy consumption decreases. The economic benefits to society from reduced consumption of energy are the sum of these direct and indirect savings values. There are numerous components to avoided costs to account separately for energy and peak capacity reductions and to reflect electric generation, transmission, and distribution ("T&D") and natural gas and delivered fuels avoided costs.

Avoided Energy Costs

Avoided energy costs are created when utilities do not have to purchase electricity or natural gas because a consumer has invested in EE infrastructure and reduced its total consumption. The reductions in wholesale purchases by the utility represent a net savings to society equal to the quantity of avoided electricity or natural gas multiplied by the wholesale cost of procuring that energy, including capacity and other associated costs. For purposes of measuring these benefits, the NJCT considers the following factors:

- Avoided wholesale electric energy costs using Forward Market Data (in $/MW-hour);
- Avoided wholesale electric capacity costs using the PJM capacity rate (in $/MW-day);
- Avoided wholesale electric transmission and distribution capacity costs (in $/kw-year);
- Avoided wholesale electric ancillary costs;
- Avoided wholesale natural gas supply costs using NYMEX futures contract prices; and
- Avoided delivered fuel costs.

Avoided Wholesale Electric Energy Costs Using Forward Market Data:

Avoided Wholesale Electric Energy Costs should be calculated using a forward-looking jurisdictional-specific monthly forecast of on- and off-peak prices utilizing recent forward/future traded settlements. If zonal forwards are unavailable, Western Hub forwards should be congestion-adjusted to the applicable jurisdiction. Utilities should use Utility-specific data if available; State programs should use NJ-hub specific data. Forwards should be used for a period of no more than five years and thereafter inflated by the generation forecast for PJM-E contained in the Energy Information Administration's (EIA's) most current Annual Energy Outlook (AEO) reference case[15].

Board staff recommends that the value of avoided wholesale electricity costs be further studied for Triennium 3.

Avoided Wholesale Electric Capacity Costs Using the PJM Capacity Rate:

The NJCT calculates Avoided Wholesale Capacity Costs using PJM Base Residual Auction auction data. For periods where actual PJM auctions have occurred, the actual jurisdictional-specific auction clear price should be used. For periods after when actual auctions have occurred, the average of the three most recent utility-specific auction clearing prices should be used, escalated by an inflation rate consistent with that discussed in the Discount Rate section of these recommendations. Utilities should use utility-specific data if available; State programs should use a weighted average of clearing prices, weighted based upon the Preliminary Zonal Peak Load Forecast less Fixed Resource Requirement (FRR) load for each utility in New Jersey from PJM's most current planning parameters.

Board staff recommends that the value of capacity avoided costs be further studied for Triennium 3.

Avoided Wholesale Electric Transmission and Distribution Capacity Costs

The NJCT estimates the direct benefits of avoided wholesale PJM transmission costs using the most recent Network Integration Transmission Service ("NITS") Rate, as measured in dollars per kw-year, as applicable to individual utility service territories.[16] The NJCT calculates the direct benefits of avoided electric distribution costs by determining the applicable distribution rate for each customer enrolled in the program based on the customer's specific customer class and usage. The savings is determined by determining the total annual distribution charges that the customer would have paid before its participation in the program and then subtracting the total distribution charges the customer paid after the implementation of the EE measures.

Board staff recommends that the value of avoided electricity and natural gas T&D be further studied for Triennium 3.

Avoided Wholesale Electric Ancillary Costs

The NJCT calculates the avoided wholesale electric energy and ancillary services ("E&AS") costs using a three-year rolling average taken from PJM's most recent State of

[15] For example: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=62-AEO2023&region=5-10&cases=ref2023&start=2021&end=2050&f=A&linechart=ref2023-d020623a.5-62-AEO2023.5-10&map=&sourcekey=0

[16] See, for example: https://www.pjm.com/-/media/markets-ops/settlements/network-integration-trans-service-september-2022.ashxTh

the Market Report. This rate should be escalated at the same rate as the avoided electric energy cost over the long-term.

Avoided Wholesale Natural Gas Supply Costs

The NJCT includes avoided natural gas consumption costs, using New York Mercantile Exchange (NYMEX) futures contract prices for Henry Hub multiplied by the quantity of gas not purchased. The utility may include actual gas transportation rates and any local distribution company transportation rates to determine the full delivered cost of gas for any individual customer.

Board staff recommends that the value of avoided Natural Gas supply costs be further studied for Triennium 3.

Avoided Delivered Fuel Costs

The value of avoided delivered fuel costs (propane or fuel oil) should be included in the NJCT. Avoided costs for #2 fuel oil and propane should be calculated using a three-year rolling average of historic EIA New Jersey residential fuel oil and propane prices escalated using an annual growth rate derived from the Mid-Atlantic Region EIA Annual Energy Outlook projections.[17]

Additional Indirect Energy Benefits

In addition to the direct and indirect energy benefits resulting from the avoided costs outlined above, the reduced load associated with EE and PDR deployment also may reduce indirect energy and capacity prices for all New Jersey consumers. PJM operates a single-clearing price market, and the price is set at the point that supply and demand meet. PJM determines the clearing price by creating a "supply stack" of all eligible resources based on their strike price. The least expensive resources are lower on the supply stack and are selected first. The next least expensive resource is selected next, and so on, until supply matches the anticipated demand. The theory describing the impact of decreasing demand on wholesale energy prices is often referred to as the Demand-Reduction-Induced Price Effect ("DRIPE") and may occur in both the PJM energy and capacity markets.

DRIPE effects are relatively small when expressed in terms of an impact on market prices. However, DRIPE impacts can be significant when expressed in absolute dollar terms when applied to all wholesale purchases by New Jersey consumers.

As literature has been updated over the past few years, and a lack of consensus on calculating the various DRIPE benefits, Board staff has determined that Electric Energy DRIPE, Electric Capacity DRIPE, and Natural Gas DRIPE impacts need further research on appropriate and defensible methods. For Triennium 2, Staff recommends allowing an

[17] For example: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2023&region=1-2&cases=ref2023&start=2021&end=2050&f=A&linechart=ref2023-d020623a.3-3-AEO2023.1-2&map=ref2023-d020623a.4-3-AEO2023.1-2&sourcekey=0

adder to account for possible indirect price changes due to EE program implementation. A DRIPE adder of 5% of avoided wholesale and capacity costs for electricity and 5% of the avoided wholesale natural gas supply cost.

Non-Energy Impacts

There are three general types of non-energy impacts ("NEIs"): (1) utility NEIs, such as reduced arrearages and debt collection costs; (2) participant NEIs, such as reduced operations and maintenance costs; impacts on occupant health and productivity; and increased property values; and (3) societal NEIs, such as economic development, environmental, and public health impacts. Including NEIs will ensure that the NJCT reflects a symmetrical treatment of costs and benefits and accounts for the full range of benefits that are not captured in traditional avoided costs.

It is common practice for jurisdictions to account for NEIs in their cost-effectiveness tests. NEIs are typically included through measured values, adders, or a combination of these two approaches. Measured NEIs are derived from independent studies of efficiency programs or measures that use methodologies such as utility data analysis, engineering models, or surveys and interviews. NEI adders apply a multiplier to total energy or resource benefits, thereby serving as a proxy for impacts that have yet to be evaluated in a jurisdiction. While measured NEIs are more precise than adders, the studies needed to develop values can be costly, time consuming, and difficult for hard to quantify impacts. Adders provide a simpler method to account for NEIs in the absence of specific evaluations that precisely measure their values.

Many jurisdictions have approved the use of adders to account for general non-energy benefits. General non-energy benefit adders range from 5% in Washington D.C. to 20% in Colorado. Nevada, New Hampshire, and Montana use a general adder of 10% to account for the range of benefits attributable to energy efficiency programs.[18] These adders reflect a range of impacts including public health, water resources, and economic development.

Jurisdictions also often include separate adders for specific programs such as those that serve low-income customers. Low-income programs provide many difficult to quantify benefits beyond energy savings, which include improved household health and safety, improved comfort, reduced energy burden, and others. States that include additional adders in their cost-effectiveness tests to account for hard to measure low-income program benefits are Colorado (25%), Nevada (25%), New Mexico (20%), New Hampshire (20%), and Vermont (15%).[19] It is important that these benefits are captured

[18] National Efficiency Screening Project, Database of State Efficiency Screening Practices, *available at* https://www.nationalenergyscreeningproject.org/state-database-dsesp/

[19] *Id.*

in the NJCT, given the CEA's focus on serving the needs of the state's low-income customers and communities.

Adders may serve as interim proxies for non-energy benefits and be updated and refined as more precise values become available. The adders included in the NJCT will be evaluated during the Triennium 2 and refined or replaced with measured values as the EM&V WG undertakes state-specific NEI studies.

Avoided Emissions Impacts

Carbon dioxide (CO_2)

The starting year quantity of avoided electric CO_2 emissions should be calculated in tons per MWh based upon the average of on-peak and off-peak marginal emissions in the most recent PJM Emissions rate report[20], de-escalated to a value equivalent to a 50 percent reduction in $C0_2$ emissions by 2050, as compared to the initial 2022 PJM-based value. This value represents a significant decarbonization of electricity generation and is similar to the rate of emissions reductions estimated in the 2023 EIA AEO for the Middle Atlantic region (reference case)[21]. The quantity of avoided natural gas emissions should be calculated based upon the Natural Gas Emissions Values published by EIA (11.7 pounds per therm saved of CO_2[22]), un-escalated into the future.

SO_2, NO_X, & $PM_{2.5}$

The starting year quantity of avoided electric (SO_2 and NO_X) emissions should be calculated in tons per MWh based upon the average of on-peak and off-peak in the most recent PJM Emissions rate report[23], de-escalated $_2$ to a value equivalent to a 50 percent reduction in emissions rate by 2050, as compared to the initial 2022 PJM-based value. This value represents a significant reduction in the fossil-based emissions of electricity generation and is similar to the rate of emissions reductions estimated in the 2023 EIA AEO for the Middle Atlantic region (reference case)[24].The quantity of avoided natural gas emissions should be calculated based upon the Natural Gas Emissions Values

[20] For example: Table 2 of the report, *PJM 2017–2021 CO2, SO2 and NOX Emission Rates,* April 18, 2022

https://pjm.com/-/media/library/reports-notices/special-reports/2021/2021-emissions-report.ashx

[21] For example: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=17-AEO2023&region=1-2&cases=ref2023&start=2021&end=2050&f=A&linechart=ref2023-d020623a.3-17-AEO2023.1-2&map=ref2023-d020623a.4-17-AEO2023.1-2&sourcekey=0

[22] https://www.eia.gov/environment/emissions/co2_vol_mass.php

[23] For example: Table 3 and Table 4 of the report, *PJM 2017–2021 CO2, SO2 and NOX Emission Rates,* April 18, 2022https://pjm.com/-/media/library/reports-notices/special-reports/2021/2021-emissions-report.ashx

[24] For example: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=17-AEO2023&region=1-2&cases=ref2023&start=2021&end=2050&f=A&linechart=ref2023-d020623a.3-17-AEO2023.1-2&map=ref2023-d020623a.4-17-AEO2023.1-2&sourcekey=0

contained in the New Jersey 2023 Triennial technical resource Manual (0.0092 pounds per therm saved of NO_X), un-escalated into the future.

Avoided SO_2 and NO_X damage values should be calculated for electric and natural gas using the average of the high case and low case estimates from the EPA report (updated in January 2022) entitled *Estimating the Benefit per Ton of Reducing Directly-Emitted PM2.5, PM2.5 Precursors and Ozone Precursors from 21 Sectors*.

Board staff recommends that the value of avoided emissions be further studied for Triennium 3.

Economic Development Benefits

Economic Development benefits are included in the General NEB adder as described below. Staff recommends that the Board take more time to consider a recommended input for Triennium 3, especially given the large weight that the proposed economic developments input has relative to the overall NJCT.

For Triennium 2, estimates of economic development benefits may be included in Societal Cost Test

Non-Energy Benefits & Low-income Benefits

Using the findings of SERA's *Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs): Analysis of Alternatives for The State of New Jersey Updates*, and other sources, the NJCT should incorporate a General NEB adder of 15% (applied to avoided wholesale energy cost) for all programs. This General NEB adder represents the average adder from the Top 16 ACEEE Scorecard states (excluding NJ) in the SERA study (Figure 0.2). Low- and moderate-income programs should have a total adder of 30% (applied to avoided wholesale energy costs), comprised of the 15% NEB adder plus an additional 15% for low- and moderate-income customers. This Low Income adder represents the average adder from the Top 16 ACEEE Scorecard states (excluding NJ) in the SERA study (Figure 0.2).

	Benefit-Cost Category	Include in NJCT for Triennium 2?	Include Change from NJCT Straw?	Summary of Comments	Responses
1	Avoided Electric Energy Costs	Yes	Yes	Rate Counsel does not support the Straw's proposal to change the method by which avoided electric energy costs are calculated in the NJCT. There are no specified challenges with the current method and no analysis on how this would affect CE has been performed.	Staff thanks Rate Counsel for their detailed responses to the Avoided Electric Energy Cost methodology. Staff believes that the proposed method, while not yet addressing changing grid mix over time, is reasonable and more consistent with avoided cost standard practice than prior backwards looking method. Staff recommends including this category in a future Avoided Cost study for Triennium 3 NJCT.
2	Avoided Electric Capacity Costs	Yes	Yes	Rate Counsel asserts that there is no evidence showing how the changing method would either improve the NJCT results or lead to CE outcomes that would more favorably balance ratepayer interests with statutory EE goals and requirements	Staff thanks Rate Counsel for their detailed responses to the Avoided Electric Capacity Cost methodology. Staff believes that the proposed change is reasonable and only slightly different from the prior method. Staff recommends including this category in a future Avoided Cost study for Triennium 3 NJCT.
3	Avoided Electric T&D Costs	Yes	No	NJUA notes that the Utilities are working with Gabel Associates to determine this value, based on secondary research of other studies, and will provide these values and their support for these values in their filings. Rate Counsel is strongly opposed to this proposal and recommends that the Board leave its current method of estimating avoided T&D	Staff thanks stakeholders for their comments. While the current Triennium 1 NJCT method is rate-based and does not reflect marginal, avoided costs per se, the literature-based values vary widely and cannot be assumed to meaningfully represent avoided electric T&D costs in NJ at this time. Staff notes that the current methodology results in values well above those used in many other state EE cost tests. Staff recommends that the current

	Benefit-Cost Category	Include in NJCT for Triennium 2?	Include Change from NJCT Straw?	Summary of Comments	Responses
				cost benefits unchanged. Specifically, the Straw proposal is definitionally vague and ambiguous.	Triennium 1 NJCT methodology be continued in Triennium 2 but that a study should be conducted by, or under oversight of, BPU to estimate marginal T&D values for NJ utilities for Triennium 3 NJCT.
4	Avoided Natural Gas T&D Costs	No	No	NJUA notes that the Utilities are working with Gabel Associates to determine this value, based on secondary research of other studies, and will provide these values and their support for these values in their filings. Rate Counsel states that the Straw Proposal is not based on actual New Jersey utility-specific data and should be rejected given its inconsistency with past Board policies preferring avoided T&D benefits (like those for electric utilities) be tied to actual New Jersey-specific data, not a broad survey of information or other non-New Jersey-based data. Rate Counsel is also strongly opposed to the use of interstate transmission line construction costs as any proxy for use in a CE test.	Staff thanks stakeholders for their comments. The literature-based values vary widely and cannot be assumed to meaningfully represent avoided gas T&D costs in NJ at this time. Staff notes that the current methodology results in values well above those used in many other state EE cost tests. Staff recommends that the Avoided Natural Gas T&D not be included at this time and that a study should be conducted by, or under oversight of, BPU to estimate marginal T&D values for NJ utilities for Triennium 3 NJCT.
5	Avoided Electric Ancillary Costs	Yes	Yes	Rate Counsel does not support the proposed changes to the way avoided ancillary service costs are measured because the proposal does not address any specific modeling or measurement challenge identified in the Board's NJCT Order, does not rely on utility-specific data, and may double-count certain	Staff thanks Rate Counsel for their detailed comments on Avoided Electric Ancillary Costs. Staff believes that the proposed methodology is reasonable because the change is a clarification of source.

	Benefit-Cost Category	Include in NJCT for Triennium 2?	Include Change from NJCT Straw?	Summary of Comments	Responses
				transmission costs. Rate Counsel also questions escalation method.	
6	Avoided Natural Gas Costs	Yes	Yes	Rate Counsel notes that the current Straw proposal uses projections, not actual Henry Hub futures prices, and still proposes to inflate those prices using EIA data. No new information has been provided in the Straw to support this change.	Staff thanks Rate Counsel for their detailed comments on Avoided Natural Gas Costs. Staff believes that the proposed methodology is reasonable but will consider including the category in a future Avoided Cost study to determine longer term natural gas avoided costs for Triennium 3 NJCT.
7	Avoided Delivered Fuel Costs	Yes	Yes	Rate Counsel opposes the adoption of the Straw recommendation to utilize an escalation factor for avoided delivered fuel costs. The Board's 2020 NJCT Order did not identify a preference for calculating NJCT results in nominal values, and the Straw has provided no evidence on why nominal values are more accurate or reflect better values for the evaluating of energy efficiency measures and portfolios.	Staff thanks Rate Counsel for their detailed comments on Avoided Delivered Fuel costs. Staff believes that the proposed methodology is reasonable and a clarification of sources, not a change in method or definition. Staff will consider including the determination of long-term fuel costs in a future Avoided Cost study for Triennium 3 NJCT.
8	Electric Energy DRIPE	Yes, as part of adder	No	Rate Counsel recommends that the Board refrain from changing its current method for estimating electric energy DRIPE since the Straw lacks the explanation and support to demonstrate that it represents an improvement on the Board's current methodology given its empirical deficiencies.	Staff thanks Rate Counsel for their detailed comments on Electric Energy DRIPE. Staff believes that further research on appropriate and defensible methodology needs to be conducted on DRIPE, so for Triennium 2, DRIPE will be included as a general adder.
9	Electric Capacity DRIPE	Yes, as part of adder	No	Rate Counsel opposes this recommendation in the Straw since it is effectively the same recommendation offered in the past without any supporting evidence to show how the	Staff thanks Rate Counsel for their detailed comments on Electric Energy DRIPE. Staff believes that further research on appropriate and defensible methodology needs to be

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				recommendation will result in improvements relative to the Board's current methodologies.	conducted on DRIPE, so for Triennium 2, DRIPE will be included as a general adder.
10	Natural Gas DRIPE	Yes, as part of adder	No	Rate Counsel notes that natural gas DRIPE is currently not part of the NJCT, nor should it be for a variety of reasons, including lack of NJ-specific information or justification.	Staff thanks Rate Counsel for their detailed comments on Electric Energy DRIPE. Staff believes that further research on appropriate and defensible methodology needs to be conducted on DRIPE, so for Triennium 2, DRIPE will be included as a general adder.
11	Avoided CO2 Emissions Impacts	Yes	No	NEEP recommends New Jersey increase the metric for the Social Cost of Carbon to $128 per short ton to align with NY and MA. Rate Counsel is not opposed to clarifying that emissions data should come from eGRIDS, but recommends the Board reject the use of forecast information for the purposes of this analysis.	Staff thanks Rate Counsel for the detailed comments on Avoided CO2 emissions impacts. Staff believes that the general approach of starting with current marginal values and de-escalating based on continued reduction in carbon content of grid electricity is appropriate and consistent with New Jersey's long-term GHG reduction plans. Staff recommends a modification of the de-escalation method to a specific value of 0.5 by 2050 (with linear de-escalation), instead of direct utilization of the EIA AEO, because the EIA AEO emissions reductions are not normalized per MWh and are available at too aggregated a geographic area (Middle Atlantic). Staff also recommends that avoided CO2 emissions impacts and the monetized value be

	Benefit-Cost Category	Include in NJCT for Triennium 2?	Include Change from NJCT Straw?	Summary of Comments	Responses
					included in a BPU-led Avoided Cost study for Triennium 3 NJCT.
12	Other Avoided Emissions Impacts	Yes, NO_x & SO_2 No, $PM_{2.5}$	No	Honeywell notes that there is no benefit for avoided methane emissions and recommends including this as a benefit. Mike Winka suggests that the BPU needs to develop and include values for reducing and eliminating these emissions as a result of the Utilities EE/PDR programs as part of the New Jersey Cost Test (NJCT). Rate Counsel objects to inclusion. The Straw recommendations do not provide additional information on the benefits of inclusion, nor any New Jersey-specific evidence as requested by Staff in the prior NJCT proceeding.	Staff thanks stakeholders for their comments. Methane emissions will be further studied and considered for inclusion in Triennium 3. Regarding SO_2 and NO_x, Staff believes that the general approach of starting with current marginal values for SO_2 and NO_x and de-escalating based on continued reduction in fossil fuel-based content of grid electricity is appropriate and consistent with New Jersey's long-term GHG reduction plans. Staff recommends a modification of the de-escalation method to a specific value of 0.5 by 2050 (with linear de-escalation), instead of direct utilization of the EIA AEO because the EIA AEO emissions reductions are not normalized per MWh and are available at too aggregated a geographic area (Middle Atlantic). Staff recommends that avoided SO_2, and NO_x, emissions impacts be included in a future BPU-led Avoided Cost study for Triennium 3 NJCT. $PM_{2.5}$ is not included for Triennium 2 because no reliable published values could be found

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					but this will also be considered for further study.
13	Avoided RPS Costs	No	No	Rate Counsel notes that Avoided RPS was suggested in last NJCT proceeding and was not adopted by Board. No data has been presented in Straw proposal to warrant inclusion at this point (possible double counting of benefits, effects on customer rates)	Staff thanks Rate Counsel for their detailed comments on Avoided RPS Costs. Avoided RPS costs will not be included in Triennium 2. Staff recommends including the category in a future Avoided Cost study to determine values, if any, for Triennium 3 NJCT.
14	Avoided Volatility Costs (Hedge Benefits)	No	No	Rate Counsel recommends that this proposal be rejected since it is not based upon any firm analytic foundation. A study examining current market conditions in NJ is suggested,	Staff thanks Rate Counsel for their detailed comments on Avoided Volatility costs. Avoided volatility will not be included in Triennium 2 avoided costs, and Staff recommends including the category in a future Avoided Cost study to determine values, if any, for Triennium 3 NJCT.
15	Economic Development Benefits	No	No	Mike Winka suggests that the BPU needs to develop and include values for net economic development and jobs from the utilities EE/PDR programs as part of the NJCT. Rate Counsel urges the Board to reject the Straw's economic development variable proposal because it is entirely inconsistent with Board Staff's recognition in 2020 of the importance of evaluating both positive and negative impacts and because of the high	Staff thanks stakeholders for their comments regarding Economic Development benefits. Staff recommends that the Board take more time to develop a recommended input for Triennium 3, especially given the large weight that the proposed economic developments input has relative to the overall NJCT. For Triennium 2, estimates of economic development benefits may be included in the Societal Cost Test.

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				degree of ambiguity and subjectivity in the recommendation.	
	Cost Category				
17	Incremental Costs	Yes	No change needed.	MaGrann strongly supports the NJCTC recommendation to base applicable cost effectiveness calculations on *incremental* costs.	Staff thanks MaGrann for their supportive comments on incremental costs. Staff will use the recently completed DNV NJ IMC Study as primary source for IMCs and allow for other sources to fill gaps or if better information is demonstrated, subject to BPU oversight and approval prior to filing.
	Other Factors				
19	Other Cost Considerations			MaGrann supports the NJCT recommendation to remove non-energy policy items from the cost-effectiveness calculation e.g. workforce development initiatives. NEEP would like to propose including a metric to account for when and how energy is generated and used (similar to Total Systems Benefit in CA). NJUA requests that avoided water use be added to the NJCT as a benefit.	Staff thanks MaGrann for their supportive comments on removing non-energy policy items from CE calculation. Staff will further look into Total Systems Benefit and avoided water use benefits for Triennium 3. Avoided water use is included in the category of non-energy benefits.
20	Discount Rate	Yes	No change proposed.	Mike Winka suggests that the discount rate should be lower than 3% (possibly 1.4%). Rate Counsel recommends that the Board clarify that all variables in the NJCT be	Staff thanks Mr. Winka for his comment on the discount rate. BPU staff has determined that the 3% real discount rate is consistent with public policy objectives of the State.

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				estimated in real, not nominal terms and requests that added language regarding the conversion of a real discount rate to a nominal value be removed.	Staff thanks Rate Counsel for their detailed comments on the discount rate. The NJCT methodology does specifically indicate that 3% is a real discount rate. In light of comments received, Staff will continue to evaluate the discount rate value for future Triennia.

Comments:

There were numerous comments surrounding the recommendation for an updated value for the NEBs/NEIs (hereafter, "NEBs") adder for New Jersey. EEA-NJ, MaGrann, NJUA, and NEEP all applauded and supported the inclusion of updated and increased NEBs for New Jersey. EEA-NJ and BPA also complimented the alignment of NEBs/NEIs with goals, and NJUA and NEEP noted that the NEBs adders were based on evidence-based research and more accurately reflected benefits than prior values (although NEEP noted the study was complicated). NEEP noted that the inclusion of NEBs provides a more complete and balanced indication of the impacts of EE programs on customers, and better reflect progress toward policy goals. NJUA suggested that the values were probably still too low but were supportive of the compromise values recommended in the NJCT report and straw.

Several commenters supported the NEBs work, but also suggested that additional NEBs should be considered in the NJCT. Suggestions included: water adders (NJUA), social cost of carbon (NJUA and NEEP), methane and emissions (Honeywell), and other additional benefits and metrics related to carbon / clean energy / decarbonization issues (Tri-State and Uplight).

The possible use of NEBs to provide information about low-income, disadvantaged, and diverse communities was of interest to some commenters. Underserved and diverse communities were specifically mentioned by Tri-State. NJUA said that they would like to see an even higher low-income adder.

NEEP agreed with the SWE that the State should look to adders in the near term to quantify NEBs. They reviewed adders elsewhere and suggested values in line with the more disaggregated research identified in the New Jersey NEBs study prepared for the NJCT Committee ("NEBs study"). Specifically, for low-income, they recommended at least 20% for a base adder plus a 10% HVAC/Health adder and recommended a potential hardship adder (as developed in the NEBs study), but declined to provide a specific recommendation. For residential programs, they recommended a 10% adder base plus 10% for residential health adder for HVAC electrification; and a 15% adder for commercial programs. They noted that these recommended values align with other states that use adders and the literature reviewed in the NEBs study.

Rate Counsel expressed dissatisfaction with the evidence basis of the NEBs study. They suggested that the NEBs study did not adequately adjust or tailor the values identified in the literature. They suggested that the primary support for the NEBs values should be other state regulatory decisions rather than literature. They stated that the existing state adders of 5% and 10% extra for low income are comparable to adders in other states, and also noted that 31 states do not use NEBs. They were also dissatisfied with the process. They noted that the NEBs study overemphasized benefit and increases costs, that ratepayer effects were not considered, and that the NEBs and NJCT processes were dominated by the Utilities. Rate Counsel urged the Board to maintain NEBs adders at the current levels or, alternatively, only increase them by 5% if the Board found it necessary to increase NEBs at all.

Most central and important for Rate Counsel was their concern that increases in NEBs values in New Jersey will lead to increased higher utility program budgets. In New Jersey, the portfolio BCR or cost-effectiveness must have a ratio of at least one. With higher benefit-cost ratios resulting from inclusion of NEBs values, more programs will pass, and Rate Counsel suggested that the NJCT may no longer be a useful tool for the Board to determine if an EE program is truly cost effective and that, at that point, cost may no longer effectively be considered the Board’s concern.

Response:

Staff appreciates the positive comments about the updated values for the NEBs multipliers for New Jersey. On behalf of the State, the Statewide Evaluator worked to provide a researched, evidence-based, literature-based study to improve the values and better reflect the impacts of EE programs to customers and better reflect progress toward goals.

Staff is pleased that commenters considered additional priority NEBs related to equity, low-income, disadvantaged, and diverse communities. These comments will be considered in the refinement of the scopes for the NEBs and equity studies included in the Triennium 2 Evaluation Studies List. The issue of including value of emissions and social cost of carbon is worth noting separately. Estimates related to the Social Cost of Carbon are currently included as part of the Avoided CO_2 calculation in the NJCT, rather than in the NEBs table, and were not included in the table to avoid double-counting the benefits.

Staff is pleased that NEEP agrees with the adder-based approach used for the near-term for New Jersey and that NEEP considers the values to be in alignment with other states and the literature reviewed by the NEBs Report. The report included research to support both an overall adder and a disaggregated adder, of the style proposed by NEEP. Staff appreciates the suggestions and research, as well as the general confirmation, but considers the compromise recommendations in the straw proposal suitable for New Jersey for use in the near-term. As noted above, additional research to further refine the NEBs for the NJCT is included in the Evaluation Studies list for Triennium 2.

Staff appreciates the attention that Rate Counsel provided on the NEBs work. Staff provides several responses to the Rate Counsel comments. First, regarding comments about the quality and methods of the study and concerns that the study should be based on state data and other state regulatory decisions, Staff supports the approaches used in the study. Staff asserts that the study’s literature review focused on strong, regional studies and, for all research in the study, relied on state-vetted values – either state-vetted adders or state-vetted studies that were then vetted again for inclusion in TRMs. Twenty-three states (including DC) use NEBs, and the research within the study also identified that the adders used in New Jersey were not "comparable to other states," as stated by Rate Counsel, but rather, are the lowest of any states with adders, with no other states with those minimum values. The Straw's recommendations would be lower than D.C.'s (treated like a state) and generally higher than other states, with exceptions (New Hampshire is 25% for residential). However, even for states with lower percentage adders, some allow additional NEBs to be included above the adders, particularly "easily measured NEBs" (like the value of water savings). So, New Jersey's adders are not "comparable" but are decidedly lower than other states.

Staff have considered the recommendations from the committee, the various commenters, including those in agreement, the values recommended by NEEP, and the concerns from Rate Counsel. Staff have discussed the pros and cons of changes to the NEB adder values and weighed the desire to better reflect NEBs values in the near term, with concerns about potentially large changes. Staff reviewed the documents submitted, and Staff recommends the following values:

- 15% adders for residential and commercial programs; and
- 15% additional adder for low-income programs.

These values approximate the average existing percentage values for adders used in other states comparable to New Jersey. This recommendation provides an incremental increase, maintains the current simple structure of the State's NEBs adder, and is a bridge until more specific New Jersey research can be conducted during Triennium 2.

Another important issue is the comment on budget implications of NEBs/NEIs. Incorporating NEB/NEI adders will, as noted in the NJ NEBs study, increase the BCR, all else equal. The Rate Counsel comment implies that the Utilities must – or will be pushed to – implement all cost-effective programs or measures, and that the increased BCRs will lead to adoption of more programs and more comprehensive programs with higher associated budgets. The State's rules do not require adoption of all cost-effective programs, but require that the *adopted portfolio be cost-effective,* which is a very different threshold requirement. The NEB/NEI adder does not directly affect the budgets for the programs that the Utilities need to put in place to meet goals. The final BCRs will be higher for the set of measures, program, and, ultimately, portfolio that is adopted that will meet goals; the use of NEBs may allow more flexibility for the Utilities in measure, program, and portfolio to meet goals, but the addition of NEBs / NEIs does not directly affect the budgets needed to meet goals. Furthermore, the use of NEBs/NEIs can help prioritize programs for maximum benefit subject to a budget constraint, with the NEBs able to better reflect participant benefits from low-income programs, in this case.

However, higher NEBs will lead to more programs and measures passing the 1.0 screening and may lead to more programs being considered for inclusion to meet goals, affecting budgets. This consideration entered into the development of Staff's recommended NEBs adders.

Staff regrets that Rate Counsel feels that the process did not sufficiently consider ratepayer effects and that the process was heavily Utility-focused. The NJCT Committee had regular fortnightly meetings with its members, which included the Utilities, Rate Counsel and others. Rate Counsel had equal opportunity to participate in the process.