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**New Jersey Program Year 5 Technical Reference Manual**

**New Jersey Board of Utilities**

*New Jersey’s Clean Energy Program*TM

2/28/2025

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# 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.

## 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.

## 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.

## 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 |
| 1. 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 |
| 1. 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.

## 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.

## 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).

## 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.

## 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.

## 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 |
| 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.* |

## Peak Savings

### 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]](#footnote-2)

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]](#footnote-3)

### 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 |

## 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.

## 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.

## 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.

## Measure Lives

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.

# Residential

## Appliances

### Clothes Washer

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS |
| Baseline | Code |
| End Use Subcategory | Clothes Washer |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version | * Updated measure description to provide guidance on calculating total savings for combination washer/dryer units |

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.

Note: In the case of a combination washer/dryer unit, total equipment savings will be the sum of savings from this measure in addition to measure 2.1.2 Clothes Dryer.

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

*Where,*

Annual Fuel Savings

*Where,*

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑1 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhwasher | Annual electric energy savings attributed to clothes washer operation | Calculated | kWh/yr |  |
| ΔkWhDHW | Annual electric energy savings attributed to water heating | Calculated | kWh/yr |  |
| ΔkWhdryer | Annual electric energy savings attributed to dryer operation | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsDHW | Annual fuel savings attributed to water heating | Calculated | Therms/yr |  |
| ΔThermsdryer | Annual fuel savings attributed to dryer operation | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔH2O | Annual water savings | Calculated | Gal/yr |  |
| Cap | Capacity of clothes washer | Site-specific. If unknown, use 3.39 or SJG Tier 1 use 5.03, Tier 2 use 4.6. ETG Tier 1 use 5.09, Tier 2 use 4.64 | ft3 | [1] |
| IMEFq | Integrated Modified Energy Factor of efficient unit | Site-specific. If unknown, look up in Table 2‑3 or SJG Tier 1 use 2.37, Tier 2 use 2.97. ETG Tier 1 use 2.43, Tier 2 use 2.98 | ft3/(kWh∙cycle) | [2][3] |
| IWFq | Integrated water factor for efficient unit | Site-specific. If unknown, look up in Table 2‑8 | Gal/(cycle∙ft3) | [2][3] |
| IMEFb | Integrated Modified Energy Factor of baseline unit | Look up in Table 2‑2 | ft3/(kWh∙cycle) | [2] |
| Ncycles | Number of clothes washer cycles per year | Look up in Table 2‑4 | cycles |  |
| Fwasher,b | Fraction of total energy consumption attributed to clothes washer operation for the baseline case | Look up in Table 2‑5 | N/A | [5] |
| Fwasher,q | Fraction of total energy consumption attributed to clothes washer operation for the efficient case | Look up in Table 2‑6 | N/A | [6] |
| FDHW,b | Fraction of total energy consumption attributed to water heating for the baseline case | Look up in Table 2‑5 | N/A | [5] |
| FDHW,q | Fraction of total energy consumption attributed to water heating for the efficient case | Look up in Table 2‑6 | N/A | [6] |
| Fdryer,b | Fraction of total energy consumption attributed to dryer operation for the baseline case | Look up in Table 2‑5 | N/A | [5] |
| Fdryer,q | Fraction of total energy consumption attributed to dryer operation for the efficient case | Look up in Table 2‑6 | N/A | [6] |
| SFDHW,electric | Electric DHW savings factor | Look up in Table 2‑7 | N/A | [10] |
| SFdryer,electric | Electric dryer savings factor | Look up in Table 2‑7 | N/A | [10] |
| SFDHW,ff | Fossil fuel DHW savings factor | Look up in Table 2‑7 | N/A | [10] |
| SFdryer,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 |  |
| IWFb | Integrated water factor for baseline unit | Look up in Table 2‑2 | Gal/(cycle∙ft3) |  |
| CF | Electric coincidence factor | Look up inTable 2‑9 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑9 | N/A |  |
| Rq | 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 (ft3) | 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 ft3 | | |
| ENERGY STAR | 2.76 | 2.06 |
| CEE Tier 1 | 2.76 | 2.76 |
| CEE Tier 2 | 2.92 | |
| 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 (Fwasher) | DHW (FDHW) | Dryer (Fdryer) |
| Federal Standard | 0.07 | 0.65 | 0.28 |

Table 2‑6 Total Energy Consumption Breakdown for Efficient Case

|  |  |  |  |
| --- | --- | --- | --- |
| Efficiency Level | Clothes Washer (Fwasher) | DHW (FDHW) | Dryer (Fdryer) |
| 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 | SFDHW,electric | SFdryer,electric | SFDHW,ff | SFdryer,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 ft3) | | |
| 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 ft3) | | |
| 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

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*](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/>

### Clothes Dryer

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS |
| Baseline | Code |
| End Use Subcategory | Clothes Washer |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version | * Updated measure description to provide guidance on calculating total savings for combination washer/dryer units |

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.

Note: In the case of a combination washer/dryer unit, total equipment savings will be the sum of savings from this measure in addition to measure 2.1.1 Clothes Washer.

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| CyclesAnnual | 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]](#footnote-4) | Hrs/yr | [14][16] |
| Load | Average total weight of clothes per drying cycle | Look up in Table 2‑11 | lbs | [14] |
| Felec,b | Percentage of energy consumed that is derived from electricity for baseline condition | Look up in Table 2‑11 | N/A | [15][16] |
| CEFb | Combined energy factor for baseline condition | Look up in Table 2‑11 | lb/kWh | [13] |
| Felec,q | Percentage of energy consumed that is derived from electricity for efficient  condition | Look up in Table 2‑11 | N/A | [15][16] |
| CEFq | Combined energy  factor for efficient case | Site-specific. If unknown, look up in Table 2‑11 | lb/kWh | [12] |
| Ffuel,b | Percentage of energy consumed that is derived from fossil fuel for baseline condition | Look up in Table 2‑11 | N/A | [15][16] |
| Ffuel,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 | Felec,b | Felec,q | Ffuel,b | Ffuel,q | CEFb | CEFq  (Energy Star) | CEFq  (Energy Star Most Efficient) |
| Vented Gas Dryer | 8.45 | 0.16[[4]](#footnote-5) | 0.16 | 0.84[[5]](#footnote-6) | 0.84 | 3.30 | 3.48 |  |
| Ventless or Vented Electric, Standard ≥ 4.4 ft3 | 8.45 | 1.00 | 1.00 | 0.00 | 0.00 | 3.73 | 3.93 | 4.3 |
| Ventless or Vented Electric, Compact (120V) < 4.4 ft3 | 3.00 | 1.00 | 1.00 | 0.00 | 0.00 | 3.61 | 3.80 | 4.3 |
| Vented Electric, Compact (240V) < 4.4 ft3 | 3.00 | 1.00 | 1.00 | 0.00 | 0.00 | 3.27 | 3.45 | 4.3 |
| Ventless Electric, Compact (240V) < 4.4 ft3 | 3.00 | 1.00 | 1.00 | 0.00 | 0.00 | 2.55 | 2.68 | 3.7 |

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

1. California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020.
2. 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>
3. 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](https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430" \l "430.32)
4. *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>
5. *Mid-Atlantic Technical Reference Manual (TRM) V10.* (2020). <https://neep.org/sites/default/files/media-files/trmv10.pdf>
6. 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>
7. Northwest Energy Efficiency Alliance (NEEA), *Dryer Field Study*, November 2014. <https://ecotope-publications-database.ecotope.com/2014_005_1_DryerStudy.pdf>

### 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

Annual Fuel Savings

Summer Peak Coincident Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| kWhq | Annual rated electric energy use for energy efficient condition | Site-specific. If unknown, look up in Table 2‑14 | kWh | [24] |
| kWhb | Annual rated electric energy use for baseline condition | Look up in Table 2‑14 | kWh | [18] |
| Fmachine | Fraction of energy used for the dishwasher machine | 0.44 | N/A | [19] |
| Fwh | Fraction of energy used for the water heater | 0.56 | N/A | [19] |
| Hrs | Annual operating hours | 301 | Hours | [18] |
| ElecSFwh | Electric Savings Factor for water heaters | Look up in Table 2‑15 | N/A | [21] |
| FuelSFwh | 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] |
| 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 | kWhb | kWhe |
| 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

1. 10 CFR 430.32 (f)(1). [https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#p-430.32(f)(1)](https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430" \l "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.
2. ENERGY STAR Residential Appliance Savings Calculator, 2012.
3. 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).”
4. Based on NYSERDA Residential Statewide Baseline Study of New York State – July 2015.[[6]](#footnote-7) “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.
5. Per 10 CFR 430 Subpart B Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters: *6.3.2 Recovery Efficiency.*
6. 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/>
7. *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>

### 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

*Where*,

Annual Fuel Savings

*Where*,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| kWhb | Energy consumption by electric baseline cooktop | Site-specific, if unknown use abovementioned formulae | kWh | [25] |
| kWhq | 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] |
| Felec,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] |
| Ffuel,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] |
| Thermsb | Energy consumption by fossil fuel baseline cooktop | Site-specific, if unknown use abovementioned formulae. | Therms | [28] |
| 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

1. 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
2. ENERGY STAR®, Emerging Technology, 2021-2022 Residential Induction Cooking Tops, January 2023 <https://www.energystar.gov/about/2021_residential_induction_cooking_tops>
3. 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>
4. 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
5. 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.
6. Residential Energy Consumption Survey 2015, table HC3.1

### Refrigerators

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | NC/TOS/EREP/DI |
| Baseline | Code/Existing/Dual |
| End Use Subcategory | Kitchen |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

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 |  |
| ΔkWPeak, | Peak Demand Savings for Time of Sale | Calculated | kWr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| AV | Adjusted volume of refrigerator | Site-specific | ft3 |  |
| kWhq | Annual energy consumption of qualifying efficiency unit | Site-specific, if unknown look up in Table 2‑20 for ENERGY STAR specifications and Table 2‑22 for CEE specifcationsTable 2‑20 | kWh/yr | [32][35] |
| kWhb | Annual energy consumption of code-compliant baseline unit | NC/TOS: look up code efficiency in Table 2‑20. EREP/DI: use existing unit, if unknown, look up in Table 2‑21. | kWh/yr | [31] |
| Focc | Adjustment factor to account for number of occupants | Look up in  Table 2‑29, if unknown use 1.0 | N/A | [33] |
| CF | Electric coincidence factor | Look up in Table 2‑24 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑24 | N/A |  |
| HVACc | HVAC interaction factor for annual electric energy consumption | If unconditioned space, use 0, otherwise look up in Appendix F: HVAC Interactivity Factors | N/A |  |
| HVACd | HVAC interaction factor for peak demand at utility summer peak hour | If unconditioned space, use 0, otherwise look up in Appendix F: HVAC Interactivity Factors | N/A |  |
| HVACff | HVAC interaction factor for annual fossil fuel energy consumption | If unconditioned space, use 0, otherwise look up in Appendix F: HVAC Interactivity Factors | 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, kWhb[[7]](#footnote-8) | ENERGY STAR Maximum Energy Usage, kWhq[[8]](#footnote-9) |
| **Standard Size Models: 7.75 cubic feet or greater** | | |
| 1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. |  |  |
| 1A. All-refrigerators—manual defrost. |  |  |
| 2. Refrigerator-freezers—partial automatic defrost |  |  |
| 3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker. |  |  |
| 3-BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker. |  |  |
| 3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service. |  |  |
| 3I-BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service. |  |  |
| 3A. All-refrigerators—automatic defrost. |  |  |
| 3A-BI. Built-in All-refrigerators—automatic defrost. |  |  |
| 4. Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker. |  |  |
| 4-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker. |  |  |
| 4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service. |  |  |
| 4I-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service. |  |  |
| 5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker. |  |  |
| 5-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker. |  |  |
| 5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service. |  |  |
| 5I-BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service. |  |  |
| 5A. Refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. |  |  |
| 5A-BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service. |  |  |
| 6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service. |  |  |
| 7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service. |  |  |
| 7-BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service. |  |  |
| **Compact Size Models: Less than 7.75 cubic feet** | | |
| 11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost. |  |  |
| 11A.Compact all-refrigerators—manual defrost. |  |  |
| 12. Compact refrigerator-freezers—partial automatic defrost |  |  |
| 13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer. |  |  |
| 13I. Compact refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker. |  |  |
| 13A. Compact all-refrigerators—automatic defrost. |  |  |
| 14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer. |  |  |
| 14I. Compact refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker. |  |  |
| 15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer. |  |  |
| 15I. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker. |  |  |

Where

Table 2‑21 Existing Refrigerator Baseline Consumption

|  |  |  |  |
| --- | --- | --- | --- |
|  | Primary Refrigerator | Secondary Refrigerator | Freezer |
| kWhb | 1120 JCPL[[9]](#footnote-10)  958 All others | 581 | 770 JCPL  593 All others |

Table 2‑22 CEE Residential Refrigerator Efficiency Specification

|  |  |
| --- | --- |
| Efficiency Level | Percent Improvement Over Measured[[10]](#footnote-11) Federal Minimum Efficiency Standard |
| CEE Tier 1[[11]](#footnote-12) | 10 |
| CEE Tier 2 | 15 |
| CEE Tier 3 | 30 |

Table 2‑23 Occupant Adjustment Factor

|  |  |
| --- | --- |
| Number of Occupants | Focc |
| 0 | 1.00 |
| 1 | 1.05 |
| 2 | 1.10 |
| 3 | 1.13 |
| 4 | 1.15 |
| 5 or more | 1.16 |
| Unknown | 1.00 |

Peak Factors

Table 2‑24 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 2‑25 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Refrigerator | 12 | 4 | [34] |

References

1. 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>
2. 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>
3. 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/>
4. 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.
5. CEE, 2022 CEE Home Appliances Initiative and Residential Refrigerator Specification, May 2022 <https://library.cee1.org/content/cee-residential-refrigerator-specification>

### Freezer

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

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:

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 freezer meeting the minimum federal efficiency standard for refrigerator efficiency as presented 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑26 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| kWhb | kWh consumption for basline case | TOS/NC: Look up code efficiency in Table 2‑27, if volume unknown use Table 2‑28  EREP/DI: Use existing unit, if unknown use Table 2‑28 | kWh/yr | [36][44] |
| kWhq | kWh consumption for energy efficient case | Site-specific, if unknown look up in Table 2‑27. If volume unknown use Table 2‑28. | kWh/yr | [37] |
| Focc | Adjustment factor to account for number of occupants | Look up in  Table 2‑29. If unknown use 1.0 | N/A | [42] |
| HVACc | HVAC interaction factor for annual electric energy consumption | 0.080. If unconditioned space use 0 | N/A | [43] |
| HVACd | HVAC interaction factor for peak demand at utility summer peak hour | 0.175. If unconditioned space use 0 | N/A | [43] |
| HVACff | 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 2‑30 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑30 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life | See Measure Life Section | Years |  |

Table 2‑27 Freezer Baseline and Efficient Annual kWh Consumption

|  |  |  |  |
| --- | --- | --- | --- |
| Product Class | | Baseline Annual kWh Consumption (kWhb) [36] | Energy Efficient Annual kWh Consumption (kWhq) [37] |
| Full-Size Freezers, where AV is adjusted volume | | | |
| 8. Upright freezers with manual defrost |  | |  |
| 9. Upright freezers with automatic defrost without an automatic icemaker |  | |  |
| 9I. Upright freezers with automatic defrost with an automatic icemaker |  | |  |
| 9-BI. Built-In upright freezers with automatic defrost without an automatic icemaker |  | |  |
| 9I-BI. Built-in upright freezers with automatic defrost with an automatic icemaker |  | |  |
| 10. Chest freezers and all other freezers except compact freezers |  | |  |
| 10A. Chest freezers with automatic defrost |  | |  |
| Compact Freezers, where AV is adjusted volume | | | |
| 16. Compact upright freezers with manual defrost | |  |  |
| 17. Compact upright freezers with automatic defrost | |  |  |
| 18. Compact chest freezers | |  |  |

If freezer volume is unknown, use the default consumption values in Table 2‑28.

Table 2‑28 Default Values

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Product Category | AV (assumed) | kWhb | kWhq | Market Share Weighting [38] |
| Upright Freezer | 24.4 | 770 JCPL  593 All others | 395 | 36.74% |
| Chest Freezer | 18.0 | 770 JCPL  593 All others | 215 | 63.26% |
| Weighted Average |  | 770 JCPL  593 All others | 281 | 100% |

Table 2‑29 Occupant Adjustment Factor

|  |  |
| --- | --- |
| Number of Occupants | Focc |
| Unknown | 1.00 |
| 1 | 1.05 |
| 2 | 1.10 |
| 3 | 1.13 |
| 4 | 1.15 |
| 5 or more | 1.16 |

Peak Factors

Table 2‑30 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 2‑31 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Freezer | 11 | 3.66 | [41] |

References

1. “Electronic Code of Federal Regulations (ECFR).” 2020. https://www.ecfr.gov/cgi-bin/ ‌
2. “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.
3. 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.
4. 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.
5. 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).
6. ENERGY STAR assumes 11 years based on Appliance Magazine U.S. Appliance Industry: Market Value, Life Expectancy & Replacement Picture for 2005-2012, 2011.
7. The Occupant Adjustment Factor is developed from simulating audits within the ORNL weatherization tool, National Energy Audit Tool (NEAT), Oak Ridge National Laboratory, 2012.
8. From NY TRM V10, Pg 1162
9. JCPL PY2 Evaluation

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑32 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Hr | Annual hours of operation | Site-specific. If unknown, assume 8,760 | Hrs |  |
| kWhb | Energy use of baseline water cooler | Look up in Table 2‑33 | kWh/day | [45] |
| kWhq | Energy use of energy efficient water cooler | Site-specific. If unknown, look up in Table 2‑33 | kWh/day | [46] |
| CF | Electric coincidence factor | Look up in Table 2‑34 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑34 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑33 Water Cooler Energy Use

|  |  |  |
| --- | --- | --- |
| Energy Star Water Cooler Type Product Capacity Class, and Conditioning Method | Baseline kWhb (kWh/day) | Default Efficient kWhq (kWh/day) |
| Cold Only | 0.16 | 0.16 |
| Hot & Cold – Low Capacity[[12]](#footnote-13) | 0.87 | 0.68 |
| Hot & Cold – High Capacity[[13]](#footnote-14) | 0.87 | 0.80 |
| Hot & Cold On-Demand | 0.18 | 0.18 |

Peak Factors

Table 2‑34 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1.0 | [47] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 10 years. [45]

References

1. ENERGY STAR Product Specification for Water Coolers Version 2.0.  
   <https://www.energystar.gov/sites/default/files/specs//ES%20WC%20V2%200%20Spec.pdf>
2. 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>
3. Assumes 24/7 operation. Site-specific load shape information should be used if known.

### Air Purifier

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS |
| Baseline | ISP |
| End Use Subcategory | Indoor Environment |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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[51].

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

*Where,*

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑35 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWhb | Annual electric consumption of the baseline case | Calculated | kWh/yr |  |
| kWhq | Annual electric consumption of the efficient case | Calculated | kWh/yr |  |
|  |  |  |  |  |
| CADRb | Clean Air Delivery Rate (CADR) for baseline air purifier | Use same value as CARDq | cfm | [48] |
| CADR\_per\_wattb | Clean Air Delivery Rate (CADR) per watt for baseline air purifier | Look up in Table 2‑36 | cfm/Watt | [48] |
| PartialPowerb | Partial On Mode Power for baseline air purifier by category | Look up in Table 2‑36 | Watts | [48] |
| CADRq | Clean Air Delivery Rate (CADR) for efficient air purifier | Site-specific. If unknown, look up in Table 2‑37 | cfm | [49] |
| CADR\_per\_wattq | Clean Air Delivery Rate (CADR) per watt for efficient air purifier | Site-specific. If unknown, look up in Table 2‑37 | cfm/watt | [49] |
| PartialPowerq | Partial On Mode Power for efficient air purifier by category | Site-specific. If unknown, look up in Table 2‑37 | Watts | [49] |
| Hrs | Annual active operating hours | 5,840 | Hrs | [51] |
| CF | Electric coincidence factor | Look up in Table 2‑40 | 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 2‑36 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 2‑37 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 2‑38 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 2‑39 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 2‑40 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.667[[14]](#footnote-15) |  |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 9 years [50].

References

1. “New Jersey A5160 | 2020-2021 | Regular Session.” n.d. LegiScan. Accessed December 21, 2022. <https://legiscan.com/NJ/text/A5160/2020>
2. “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>
3. 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>
4. “ENERGY STAR Appliance Calculator”. <https://www.energy.gov/energysaver/maps/appliance-energy-calculator>. n.d. Accessed December 21, 2022.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑41 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 | [52] |
| IEFb | Baseline Integrated Energy Factor | Look up in Table 2‑42, Table 2‑43 | liters/kWh | [53] |
| IEFq | Energy Efficient Integrated Energy Factor | Site-specific. If unknown, look up in Table 2‑44, Table 2‑45 | liters/kWh | [54] |
| 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 2‑46 | N/A | [55] |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑42 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 2‑43 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 2‑44 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 2‑45 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 2‑46 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.405 | [55] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 12 years[56].

References

1. 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
2. 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)>
3. ENERGY STAR® Program Requirements Product Specification for Dehumidifiers, Eligibility Criteria Version 5.0, October 2019
4. 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.
5. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (TRM), Version 10, January 2023.

### 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 2‑48.

Baseline Case

The baseline condition is a room AC unit that meets the minimum federal efficiency standards [57] 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) [58]. 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑47 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Cap | Capacity of energy efficient equipment | Site-specific | Btu/hr |  |
| CEERq | Combined Energy Efficiency Ratio of ENERGY STAR unit in Btus per Watt-hour | Site-specific. If unknown, look up in Table 2‑48 | Btu/Wh | [61] |
| CEERb | Combined Energy Efficiency Ratio of baseline unit in Btus per Watt-hour | Look up in Table 2‑48, if unknown use 11.0[[15]](#footnote-16) | Btu/Wh | [57] |
| EFLH­c | Cooling equivalent full-load hours | 600 | Hours | [63] |
| 1,000 | Conversion from W to kW | 1,000 | W/kW |  |
| CF | Electric coincidence factor | Look up in Table 2‑49 | N/A | [62] |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑48 Standard and ENERGY STAR CEER Values for Room Air Conditioner

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Product Type and Class (Btu/hour) | | Federal standard with louvered sides (CEERb) | Federal standard without louvered sides (CEERb) | ENERGY STAR with louvered sides (CEERq) | ENERGY STAR without louvered sides (CEERq) |
| 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 2‑49 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.31 | [62] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 12 years. [59]

References

1. 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>

1. “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>
2. 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>
3. NEEP, Mid-Atlantic Technical Reference Manual, V10. pp 70-71., April 2020, <https://neep.org/sites/default/files/media-files/trmv10.pdf>
4. “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>.
5. 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>.
6. VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.

## Appliance Recycling

### Refrigerator & Freezer Recycling

|  |  |
| --- | --- |
| Market | Residential |
| Baseline Condition | ERET |
| Baseline | Existing |
| End Use Subcategory | N/A |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version | * Added compact refrigerators |

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[[16]](#footnote-17) (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 also includes 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.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑50 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔkWh/unit | Energy Savings per unit | Look up in Table 2‑51 | kWh | [65] |
| ΔkW/unit | Demand Savings per unit | Look up in Table 2‑51 | kWh | [65] |
| CF | Electric coincidence factor | Look up in Table 2‑52 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 2‑52 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [64] |

Table 2‑51 Default Values for Annual Energy and Peak Demand Savings

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Primary Refrigerator | Secondary Refrigerator | Freezer | Compact Refrigerator[[17]](#footnote-18) |
| ΔkWh/unit | 1,120 JCPL[[18]](#footnote-19)  958 All others | 581 | 770 JCPL  593 All others | 295 |
| ΔkW/unit | 0.15 | 0.10 | 0.10 | 0.03 |

Peak Factors

Table 2‑52 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 [64].

References

1. 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. 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. JCPL PY2 Evaluation

Keeling, J.; Bruchs, D. (2017). Chapter 7: Refrigerator Recycling Evaluation Protocol. The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68563. http://www.nrel.gov/docs/fy17osti/68563.pdf

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑53 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Hrs | Run hours of window AC unit | 600 | Hours | [63] |
| Btuh | Capacity of replaced unit | Site-specific, if unknown assume 7,829 | Btu/hr | [69] |
| EERexist | Efficiency of existing unit | Site-specific, if unknown assume 9.8 | Btu/W/hr | [70] |
| 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 | [72] |
| CF | Electric coincidence factor | Look up in Table 2‑54 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑54 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 2‑54 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.3 | [71] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 3 years. [67]

References

1. 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. VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.
3. 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>
4. 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.
5. 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>
6. Source: Cadmus analysis, EmPOWER 2018 P1 & P2 ARP participant survey

### Dehumidifier Recycling

|  |  |
| --- | --- |
| Market | Residential |
| Baseline Condition | ERET |
| Baseline | Existing |
| End Use Subcategory | Dehumidifier |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑55 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 2‑56 based on manufacture date. If unknown, assume manufactuer date later than October 2012.[[19]](#footnote-20) | L/kWh | [75][76][77] |
| 0.473 | Conversion factor | 0.473 | L/pint |  |
| 24 | Conversion factor | 24 | Hr/day |  |
| Hrs | Hours of use[[20]](#footnote-21) | Site-specific. If unknown use 1,632 | Hours/yr | [74] |
| CF | Electric coincidence factor | Lookup in Table 2‑56 | N/A |  |
| PDF | Gas peak day factor | Lookup in Table 2‑56 | N/A |  |
| RUL | Remaining useful life | See Measure Life Section | Years | [73] |

Table 2‑56 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 |
| >75 to ≤ 185 | 3.30 | 2.25 | 2.50 |

Peak Factors

Table 2‑57 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.405 | [78] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The remaining useful life (RUL) is 4 years [73].

References

1. 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.
2. Savings Calculator for ENERGY STAR® Qualified Appliances Version 3.0 Last Updated October 1, 2012.
3. ENERGY STAR® Program Requirements for Dehumidifiers, Version 5.0, February 2019.
4. 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>
5. 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>
6. 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.

## HVAC

### Air Source Heat Pumps and Mini-Split Heat Pumps

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/NC/EREP/DI |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version | * Clarified guidance on baselines assumptions for midstream applications: when to assume partial vs. whole displacement and fuel-switching vs. non-fuel switching |

Description

This measure targets the use of air source heat pumps (ASHP) and mini split heat pumps in residential and low-rise multifamily applications. This measure may apply to early replacement of an existing system, replacement on failure, or installation of a new unit in a new or existing residential or multifamily low-rise building for HVAC applications.

In certain instances, air source heat pumps and mini-split heat pumps may only partially meet the heating load, requiring a supplementary heating system to satisfy the full heating load of the dwelling. As such, this measure addresses two displacement scenarios: partial and whole.

* **Partial displacement:** the heat pump fulfils a portion of the dwelling’s heating load. Partial displacements occur in either of two scenarios: 1) the installation of a heat pump that shares the dwelling’s heating load with a separate supplemental heating system or 2) the installation of a “dual fuel” heat pump that incorporates a backup fossil fuel furnace to supplement the heat pump output. Partial displacements are addressed in the equations below by a load factor parameter (Fload), which represents the actual heating output of the heat pump as compared to the total theoretical heating output.[[21]](#footnote-22) The partial displacement scenario only applies to heating displacement; this measure assumes that the installed heat pump will serve the entire cooling load of the zone(s) affected by the installation. If the installed heat pump is not a cold-climate heat pump, assume a partial displacement scenario unless there is evidence for a whole displacement installation (such as proof that any pre-existing heating systems were removed).
* **Whole displacement:** the heat pump and any integrated supplemental resistance heat meets the dwelling’s entire heating load. May assume whole displacement scenario if the installed heat pump is a cold-climate heat pump.

This measure does not accommodate the interactive effects of concurrent weatherization upgrades.

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 the residential protocol presented in this measure.

Baseline Case

**For whole building new construction**, the baseline equipment is an air source, dual fuel or mini-split heat pump meeting the compliance requirements of IECC 2021 for single family and multifamily low-rise residential buildings (see Appendix E). Per Table R405.4.2(1) of IECC 2021, the standard reference design for residential buildings with a proposed air-source heat pump is the same heating and cooling system as proposed. For multifamily high-rise buildings, refer to the commercial heat pump measure (Section 3.5.1).

**For replacement of failed equipment**, or equipment reaching end of useful life, the baseline is a minimally code compliant version of the replaced system type and fuel. If the baseline system fuel is unknown, such as in a midstream delivery method, calculate savings using a gas baseline (fuel switching project, assume 14% boilers and 86% furnaces as baseline equipment) and electric baseline (non fuel switching project, assume ASHP as baseline equipment) and calculate the weighted average using the weights in the table below.[[22]](#footnote-23)

|  |  |  |
| --- | --- | --- |
|  | Fuel switch | Non fuel switch |
| ACE | 0.130 | 0.870 |
| JCPL | 0.216 | 0.784 |
| RECO | 0.013 | 0.987 |
| PSEG | 0.412 | 0.588 |
| **Average** | **0.193** | **0.807** |

**For early replacement** projects, use dual baselines:

* For the remaining useful life (RUL) of the existing equipment, the baseline efficiency is the efficiency of the 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 in Appendix E).
* For the duration of the measure life after the end of the RUL, the baseline is a minimally code-compliant version of the replaced equipment type and fuel.

**For spaces with no existing heating:** For previously unheated spaces in an existing home that has an existing central heating system, the customer may have planned to install a heat pump regardless of program intervention, or the customer may have planned to extend the existing central HVAC system to heat the new space. The baseline can therefore vary between a new equipment scenario and a retrofit scenario. For such installations, the baseline energy consumption algorithm is designed to blend the baseline energy consumptions of the new equipment scenario and retrofit scenario using a baseline factor, Fbaseline,h.[[23]](#footnote-24)

* New equipment scenario: absent the program, the customer would have purchased new heating equipment instead of extending the existing central heating system. The new equipment scenario baseline is a code-compliant air-source heat pump of the same size as the installed heat pump.
* Retrofit scenario: absent the program, the customer would have extended the existing central heating system instead of purchasing new heating equipment. The retrofit scenario baseline is the existing central heating equipment.

**For spaces with no existing cooling:** For homes without existing cooling, or spaces without cooling in an existing home that has an existing central cooling system, the customer may have planned to install a cooling regardless of program intervention, or the customer may have planned to leave the space without any cooling. The baseline can therefore vary between a new load scenario and a non-new load scenario. For such installations, the baseline energy consumption algorithm is designed to blend the baseline energy consumptions of the new equipment scenario and retrofit scenario using a baseline factor, Fbaseline,c.[[24]](#footnote-25)

* New load scenario: absent the program, the customer would not install any cooling. The new load scenario baseline is no existing cooling.
* Non-new load scenario: absent the program, the customer would have added cooling to the space. The non-new load scenario cooling baseline is the existing central cooling system if one exists, or a code-compliant air conditioner of the same cooling capacity as the installed heat pump.

Efficient Case

An air source heat pump or mini split heat pump that exceeds the program qualifying efficiency requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

For partial displacement applications,

If supplemental heat is an existing electric resistance heating system:

If supplemental heat is an existing fossil fuel system:

For whole displacement applications,

Calculate kWhc,b, kWhh,b, andkWhsupplement using the algorithms in Table 2‑58 for the appropriate baseline and supplemental equipment type, if applicable.

Calculate kWhc,q and kWhh,q using the algorithms in Table 2‑59 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.
* The oversize derating factor (OSF) in the equations below 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 in Table 2‑63.

Table 2‑58 Baseline or Supplemental Electric Energy Consumption Equations

|  |  |  |
| --- | --- | --- |
| Baseline Equipment | Cooling kWh (kWhc,b) | Heating kWh (kWhh,b orkWhsupplement) |
| No existing cooling |  | N/A |
| No existing heating, central fossil fuel system | N/A |  |
| No existing heating, central electric resistance/electric furnace | N/A |  |
| Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h) or whole building new construction |  |  |
| Mini-split AC, Air Conditioner (Cooling Capacity < 65 kBtu/h) |  | N/A |
| PTAC with electric resistance heat |  |  |
| PTAC with fossil fuel heat |  | N/A |
| PTHP |  |  |
| Electric resistance/electric furnace heating | N/A |  |
| Room Air Conditioner |  | N/A |

Table 2‑59 Energy Efficient Electric Energy Consumption Equations

|  |  |  |
| --- | --- | --- |
| Qualifying Equipment | Efficient Cooling kWh  (kWhc,q) | Efficient Heating kWh  (kWhh,q) |
| Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h) |  |  |
| PTHP |  |  |

Annual Fuel Savings

Where,

For partial displacement applications in which the heat pump supplements an existing fossil fuel system,

For partial displacement applications in which a new supplemental fossil fuel heating system is installed,

For whole displacement applications,

Table 2‑60 Baseline Fossil Fuel Consumption

|  |  |
| --- | --- |
| Baseline Equipment | Baseline fuel consumption (Thermsb) |
| Fossil Fuel (Gas, Oil, Propane) Furnace/Boiler |  |
| No existing heating, central fossil fuel system |  |

2‑61 Energy Efficient Fossil Fuel Consumption

|  |  |
| --- | --- |
| Qualifying Equipment | Efficient fuel consumption (Thermsq,ff) |
| New Supplemental Fossil Fuel (Gas, Oil, Propane) Furnace/Boiler |  |

To calculate savings in gallons of delivered fuel, use Table 3‑200.

Table 2‑62 Fuel Savings in Gallons

|  |  |
| --- | --- |
| Delivered Fuel | Fuel savings (gallons) |
| Oil |  |
| Propane |  |

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Use single baseline for whole displacement new construction and replace on failure.

Use dual baseline for early replacement addition to existing equipment. In both cases, the RUL is defined by the smaller of the pre-existing heating or cooling system RUL.

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑63 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔGalOil | Oil savings | Calculated | Gallons |  |
| ΔGalPropane | Propane savings | Calculated | Gallons |  |
| kWhb | Baseline electrical consumption | Calculated | kWh/yr |  |
| kWhq | Energy efficient electrical consumption | Calculated | kWh/yr |  |
| Capc | Cooling capacity of installed unit | Site-specific | Btu/hr |  |
| Caph | Heating capacity of installed heat pump heating equipment | Site-specific | Btu/hr |  |
| SEER2q | SEER2 of installed unit | Site-specific | Btu/W-h |  |
| EER2q | EER2 of qualifying unit | Site-specific | Btu/W-h |  |
| COPq | Coefficient of performance of the qualifying unit at 47F | Site-specific | N/A |  |
| HSPF2q | HSPF2 of the installed unit | Site-specific | Btu/W-h |  |
| SEER2b | SEER2 of baseline unit | Site-specific or lookup in Appendix E | Btu/W-h | [79][80][85][86] |
| EER2b | EER2 of baseline unit | Site-specific or lookup in Appendix E | Btu/W-h | [79][80][85][86] |
| HSPF2b | HSPF2 of the baseline unit | Site-specific or lookup in Appendix E. | Btu/W-h | [79][80][85][86] |
| CEERb | Combined Energy Efficiency Ratio of baseline room air conditioner[[25]](#footnote-26) | Use federal standard values in Appendix E, if unknown, use 11.0 | Btu/W-h |  |
| Effb,fuel | Efficiency of baseline boiler/furnace | Site-specific or lookup in Appendix E | N/A | [79][80][84] |
| Effq,fuel | Efficiency of newly installed supplemental boiler/furnace | Site-specific | N/A |  |
| OSF | Oversize derating factor[[26]](#footnote-27) | Site-specific, if unknown, use 0.8 | N/A |  |
| Fload | Partial Displacement Factor to account for the portion of heating load met by the heat pump | Lookup in Table 2‑64 | N/A | [88][90] |
| Fbaseline,h | Fraction of projects where, absent the program, the customer would have purchased new heating equipment for a previously unheated space instead of extending existing central system | If installed heat pump is a ductless minisplit: 0.18  If installed heat pump is a ducted ASHP: 0.27 | N/A | [93] |
| Fbaseline,c | Fraction of projects where, absent the program, the customer would not have installed cooling in previously uncooled space, so the added cooling represented added electrical load | If installed heat pump is a ductless minisplit: 0.74  If installed heat pump is a ducted ASHP: 0.34 | N/A | [93] |
| kWhc,b | Baseline cooling electrical consumption, whole displacement | Calculated from Table 2‑58 | kWh/yr |  |
| kWhh,b | Baseline heating electrical consumption, whole displacement | Calculated from Table 2‑58 | kWh/yr |  |
| kWhc,q | Energy efficient cooling electrical consumption, whole displacement | Calculated from Table 2‑59 | kWh/yr |  |
| kWhh,q | Energy efficient heating electrical consumption, whole displacement | Calculated from Table 2‑59 | kWh/yr |  |
| kWhh,supplement | Energy efficient heating electrical consumption of supplemental heating system | Calculated | kWh/yr |  |
| Thermsb | Baseline fuel consumption | Calculated from Table 2‑58 | Therms/yr |  |
| Thermsq | Energy efficient fuel consumption | Calculated | Therms/yr |  |
| Thermsq,ff | Fuel consumption of new efficient fuel equipment for partial displacement applications where a new supplemental fossil fuel heating system is installed | Calculated | Therms/yr |  |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Lookup in Appendix C | Hours |  |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C | Hours |  |
| COPb | Coefficient of performance of the baseline PTHP at 47F | Lookup in Appendix C | N/A | [79][80][85][86] |
| 1,000 | Conversion from W to kW | 1,000 | W/kW |  |
| 3.412 | Conversion factor from kWh to kBtu | 3.412 | kBtu/kWh |  |
| 1.4 | Conversion from therms to gallons | 1.4 | Therms/gal | 0 |
| 0.916 | Conversion from therms to gallons | 0.916 | Therms/gal | 0 |
| CF | Cooling coincidence factor | Lookup in Table 2‑66 | N/A | [83] |
| PDF | Gas peak day factor | Lookup in Table 2‑66 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [81] |
| RUL | Remaining useful life | See Measure Life Section | Years |  |

Table 2‑64 Partial Displacement Factors for Ductless Heat Pumps[[27]](#footnote-28)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NJ Climate Region | Supplemental Fuel Type | | | |
| **Delivered (Oil/Propane)** | **Electric** | **Natural Gas** | **Unknown** |
| Northern | 0.61 | 0.45 | 0.41 | 0.43 |
| Southern | 0.46 | 0.23 | 0.26 | 0.27 |
| Coastal | 0.46 | 0.23 | 0.26 | 0.27 |
| Central | 0.46 | 0.23 | 0.26 | 0.27 |
| Pine Barrens | 0.46 | 0.23 | 0.26 | 0.27 |
| **Statewide Average** | **0.48** | **0.26** | **0.27** | **0.29** |

Table 2‑65 Partial Displacement Factors for Ducted Heat Pumps[[28]](#footnote-29)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NJ Climate Region | Switchover Point | | | | | |
| **15°F** | **25°F** | **30°F** | **35°F (default)** | **40°F** | **45°F** |
| Northern | 0.95 | 0.78 | 0.68 | 0.43 | 0.29 | 0.17 |
| Southern | 0.99 | 0.82 | 0.71 | 0.43 | 0.29 | 0.19 |
| Coastal | 0.98 | 0.91 | 0.85 | 0.64 | 0.46 | 0.30 |
| Central | 0.99 | 0.83 | 0.74 | 0.47 | 0.31 | 0.19 |
| Pine Barrens | 1.00 | 0.86 | 0.76 | 0.46 | 0.31 | 0.19 |
| **Statewide Average** | **0.98** | **0.84** | **0.75** | **0.48** | **0.33** | **0.20** |

Note: For ducted heat pumps, assume a default switchover point of 35°F unless a site-specific switchover point is known and supported with documentation such as a photo of programmed controls.

Peak Factors

Table 2‑66 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [83] |
| Natural gas peak day factor (PDF) | See Appendix G |  |

Measure Life

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

Table 2‑67 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Central A/C | 15 | 5 | [81] |
| Air source heat pump | 15 | 5 | [81] |
| Mini split heat pump | 15 | 5 | [81] |
| PTAC/PTHP | 15 | 5 | [81] |
| Room air conditioner | 12 | 4 | [91] |
| Fossil fuel furnace/boiler | 20 | 6.7 | [81] |
| Electric resistance/electric furnace | 20 | 6.7 | [81][550] |

References

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11. Oak Ridge National Laboratory*, Fuel Conversions Needed in the Weatherization Assistant*, <https://weatherization.ornl.gov/wp-content/uploads/2018/05/FuelConversions.pdf>
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### Central Air Conditioner, Mini-Split AC and PTAC

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/NC/EREP/DI |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version |  |

Description

This measure targets the use of central air conditioners (AC) , mini-split air conditioners (MSAC) and packaged terminal air conditioners (PTAC) 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.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol in Section 4.5.1. Measures in low-rise multifamily buildings or within dwelling units of high-rise multifamily buildings follow the residential protocol presented in this measure as outlined in Table 2‑58, Table 2‑69 and Table 2‑70 below.

Baseline Case

For time of sale or new construction projects, the baseline equipment is a central air conditioner, mini-split air conditioners or packaged terminal system minimally compliant with IECC 2021 (see Appendix E).

For early replacement projects or direct install 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 2013 efficiency requirements from Appendix E).
* 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.

Efficient Case

A central air conditioner, mini-split air conditioners or packaged terminal air conditioner (PTAC) that meets or exceeds program requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Calculate kWhb using the algorithms in Table 2‑58 for the appropriate baseline equipment type.

Calculate kWhq using the algorithms in Table 2‑59 for the appropriate efficient equipment type.

Note: Conversions from SEER to SEER and EER to EER2 can be found in Appendix E.

Table 2‑68 Baseline Energy Consumption Equations

|  |  |
| --- | --- |
| Baseline Equipment | Baseline Cooling kWh (kWhb) |
| Air Conditioner (Cooling Capacity < 65 kBtu/h) |  |
| Room Air Conditioner |  |
| PTAC |  |

Table 2‑69 Energy Efficient Energy Consumption Equations

|  |  |
| --- | --- |
| Qualifying Equipment | Efficient Cooling kWh (kWhq) |
| Air Conditioner (Cooling Capacity < 65 kBtu/h) |  |
| Room Air Conditioner |  |
| PTAC |  |

Peak Demand Savings

Table 2‑70 Peak Demand Savings Equations

|  |  |
| --- | --- |
| Qualifying Equipment | Peak Demand Savings (ΔkWPeak) |
| Air Conditioner (Cooling Capacity < 65 kBtu/h) |  |
| Room Air Conditioner |  |
| PTAC |  |

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑71 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWhb | Baseline electrical consumption | Calculated | kWh/yr |  |
| kWhq | Energy efficient electrical consumption | Calculated | kWh/yr |  |
| Capc | Cooling capacity of installed unit | Site-specific | Btu/hr |  |
| SEER2q | SEER2 of installed unit[[29]](#footnote-30) | Site-specific | Btu/W-h |  |
| CEERq | CEER of installed unit | Site-specific | Btu/W-h |  |
| EER2q | EER2 of qualifying unit | Site-specific | Btu/W-h |  |
| SEER2b | SEER2 of baseline unit1 | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or use 2013 if vintage is unknown | Btu/W-h | [94][95] |
| CEERb | CEER of baseline unit | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or use 2013 if vintage is unknown | Btu/W-h | [94][95] |
| EER2b | EER2 of baseline unit | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or use 2013 if vintage is unknown | Btu/W-h | [94][95] |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Look up in Appendix C | Hours |  |
| 1,000 | Conversion from W to kW | 1,000 | W/kW |  |
| CF | Electric coincidence factor | 0.69 | N/A | [97] |
| EUL | Effective useful life | See Measure Life section | Years | [96] |

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 2‑72 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Central AC, MSAC and PTAC | 15 | 5 | [96] |
| Room AC | 9 | 3 | [96] |

References

1. 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
2. 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
3. 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>
4. 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>
5. See Appendix

### Water Source Heat Pump (Groundwater and Ground Loop)

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/NC/EREP |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | May 2024 |
| Changes Since Last Version |  |

***Description***

This prescriptive measure targets the use of water source heat pumps (sometimes called geothermal 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. The following heat pump types are included in this measure.

* Water-to-air groundwater
* Water-to-air ground loop
* Brine-to-air groundwater loop
* Brine-to-air ground loop

This measure is limited to single-zone equipment; complex built-up systems should follow custom analysis. This measure requires that:

* The heat pump system will be installed in lost opportunity projects *or* in retrofit/early retirement projects in buildings with viable existing ductwork.
* The heat pump system will be the sole source of heating and cooling in the space; it will not be installed in association with another non-electric source of auxiliary heat.

*Baseline Case*

For whole building new construction and time of sale applications, the baseline equipment is an air source, dual fuel or mini-split heat pump meeting the compliance requirements of IECC 2021. However, if the preexisting failed system was a ground-source heat pump, the baseline should reflect the type and efficiency of the previous system in accordance with IECC 2021 standards. For multi-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. 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.

*Efficient Case*

A water-to-air groundwater loop water-to-air ground loop, brine-to-air groundwater loop, or brine-to-air ground loop heat pump that meets or exceeds program requirements.

***Annual Energy Savings Algorithms***

*Annual Electric Energy Savings*

Where,

Calculate kWhc,b, kWhh,b, and kWhp,b using the algorithms in **Table 2‑73** for the appropriate baseline equipment type.

Calculate kWhc,q, kWhh,q, and kWhp,q using the algorithms in **Table 2‑74** 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 cooling output of the installed unit (Qc) and the heating output of the installed unit (Qh) are calculated as follows.

The oversize derating factor (OSF) 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 a default value of 0.8.

**Table 2‑73 Baseline Energy Consumption Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| Baseline Equipment | Baseline Cooling kWh (kWhc,b) | Baseline Heating kWh (kWhh,b) | Auxiliary Energy Use kWh (kWhau,b)[[30]](#footnote-31) |
| Air Source Heat Pump (< 65 kBtu/h) |  |  | N/A |
| Air Source Air Conditioner (< 65 kBtu/h) |  | N/A | N/A |
| PTAC with electric resistance heat |  | N/A | N/A |
| PTHP |  |  | N/A |
| GSHP (< 65 kBtu/h) |  |  |  |
| Electric Resistance/electric furnace heating | N/A |  | N/A |
| Room Air Conditioner |  | N/A | N/A |
| Furnace[[31]](#footnote-32) | N/A | N/A |  |

**Table 2‑74 Qualifying Equipment Energy Consumption Equations**

|  |  |  |
| --- | --- | --- |
| Efficient Cooling kWh  (kWhc,q) | Efficient Heating kWh  (kWhh,q) | Efficient Ground/Groundwater Loop Circulating Pump kWh  (kWhp,q) |
|  |  |  |

Calculate seasonal efficiencies as follows:

If heat pump is part-load capable:

If heat pump is not part-load capable:

*Annual Fuel Savings*

Where,

*(If the unit uses a furnace backup, use equation from Table 1-3)*

**Table 2‑75 Energy Efficient Fuel Consumption**

|  |  |
| --- | --- |
| Baseline Equipment | Baseline fuel consumption (Thermsb) |
| Electric heating (heat pump, electric resistance) | 0 |
| Fossil fuel furnace |  |

To calculate savings in gallons of delivered fuel, use Table 3‑200.

Table 2‑76 Fuel Savings in Gallons of Delivered Fuel

|  |  |
| --- | --- |
| Delivered Fuel | Fuel savings (gallons) |
| Oil |  |
| Propane |  |

*Peak Demand Savings*

Where,

*Daily Peak Fuel Savings*

***Lifetime Energy Savings Algorithms***

*Lifetime Electric Energy Savings*

No dual baseline:

Dual baseline:

*Lifetime Fuel Energy Savings*

No dual baseline:

Dual baseline:

***Calculation Parameters***

**Table 2‑77 Calculation Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔthermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔthermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔGalOil | Oil savings | Calculated | Gallons |  |
| ΔGalPropane | Propane savings | Calculated | Gallons |  |
| kWhb | Baseline electrical consumption | Calculated | kWh/yr |  |
| kWhq | Energy efficient electrical consumption | Calculated | kWh/yr |  |
| Qc | Cooling output of qualifying unit | Calculated | Btu |  |
| Qh | Heating output of qualifying unit | Calculated | Btu |  |
| Capc | Cooling capacity of qualifying unit | Site-specific | Btu/hr |  |
| Caph | Heating capacity of qualifying unit | Site-specific | Btu/hr |  |
| Capfurnace | Heating capacity of pre-existing furnace (MBH) | Site-specific | MBH |  |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Lookup in Appendix C | Hours |  |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C | Hours |  |
| Ffull | Seasonal weighting factor for full load efficiency | 0.25 | N/A | [101] |
| EERseason,q | Adjusted EER of qualifying unit | Calculated | Btu/W-h |  |
| EERfull,q | Full load EER of qualifying unit | Site-specific | Btu/W-h |  |
| Fpump,full | Factor to adjust the full load efficiency to account for additional pumping power used by the system | 0.90 | N/A | [101] |
| Fpart | Seasonal weighting factor for part load efficiency | 0.75 | N/A | [101] |
| EERpart,q | Part load EER of qualifying unit (if part load capable), per manufacturer literature or AHRI certification | Site-specific | Btu/W-h |  |
| Fpump,part | Factor to adjust the part load efficiency to account for additional pumping power used by the system | 0.84 | N/A | [101] |
| COPseason,q | Adjusted coefficient of performance of the qualifying unit | Calculated | N/A |  |
| COPfull,q | Full load coefficient of performance of the qualifying unit, per manufacturer literature or AHRI certification | Site-specific | N/A |  |
| COPpart,q | Part load coefficient of performance of the qualifying unit (if part-load capable), per manufacturer literature or AHRI certification | Site-specific | N/A |  |
| HPq | Horsepower of qualifying ground/groundwater loop circulating pump motor | Site-specific | HP |  |
| HPb | Horsepower of base case ground/groundwater loop circulating pump motor | Site-specific, if unknown use HPq | HP |  |
| SEER2b | SEER of baseline unit | Site-specific or look up in Appendix | Btu/W-h | [105][106][108][109] |
| IEERb | IEER of baseline unit | Site-specific or look up in Appendix EAppendix E: Code-Compliant Efficiencies | Btu/W-h | [105][106][108][109] |
| EER2b | EER of baseline unit | Site-specific or look up in Appendix E | Btu/W-h | [105][106][108][109] |
| HSPF2b | Heating seasonal performance factor of the baseline unit | Site-specific, if unknown look up in Appendix E | Btu/W-h | [105][106][108][109] |
| CEERb | Combined Energy Efficiency Ratio of baseline room air conditioner[[32]](#footnote-33) | Use federal standard values in Appendix E, if unknown, use 11.0 | Btu/W-h | [101] |
| Effmotor,b | Efficiency of base case ground/groundwater loop circulating pump motor | Site-specific, if unknown look up in **Table 2‑78** | N/A | [107] |
| Effmotor,q | Efficiency of qualifying ground/groundwater loop circulating pump motor | Site-specific | N/A | [107] |
| Effb,fuel | Efficiency of baseline furnace | Site-specific or look up in Appendix E | N/A | [105][106] |
| OSF | Oversize derating factor | Site-specific, if unknown use 0.8 | N/A |  |
| kWhc,b | Baseline cooling electrical consumption | Calculated from **Table 2‑73** | kWh/yr |  |
| kWhh,b | Baseline heating electrical consumption | Calculated from **Table 2‑73** | kWh/yr |  |
| kWhau,b | Baseline auxiliary electrical consumption | Calculated from **Table 2‑73** | kWh/yr |  |
| kWhc,q | Energy efficient cooling electrical consumption | Calculated from **Table 2‑74** | kWh/yr |  |
| kWhh,q | Energy efficient heating electrical consumption | Calculated from **Table 2‑74** | kWh/yr |  |
| kWhp,q | Energy efficient ground/groundwater loop circulating pump electrical consumption | Calculated from **Table 2‑74** | kWh/yr |  |
| Thermsb | Baseline fuel consumption | Lookup in **Table 2‑75** | Therms/yr |  |
| Thermsq | Energy efficient fuel consumption | 0 | Therms/yr |  |
| COPb | Coefficient of performance of the baseline unit | Site-specific or look up in Appendix E | N/A | [105][106][108][109] |
| 1.09 | Correction for 9% increase in EER as the entering fluid temperature decreases from 77°F to 68°F | 1.09 | N/A | [101] |
| 1.08 | Correction for 8% increase in COP as entering fluid temperature increases from 32°F to 40°F | 1.08 | N/A | [101] |
| 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 |  |
| 1.4 | Conversion from therms to gallons | 1.4 | Therms/gal |  |
| 0.916 | Conversion from therms to gallons | 0.916 | Therms/gal |  |
| LF | Load factor of pump motor | 0.75 | N/A | [102] |
| DSFVFD | Demand savings factor to account for variable speed pumping in qualifying unit | If variable speed pump: 0.210  If constant speed: 1.0 |  | See section 2.3.6 |
| FLHpump | Annual full-load hours of ground/groundwater loop circulating pump motor, approximated as EFLHc + EFLHh | Look up in Appendix D: HVAC Fan and Pump Operating Hours | Hours |  |
| CFc | Cooling coincidence factor | Lookup in **Table 2‑79** | N/A |  |
| CFpump | Pump coincidence factor | Lookup in **Table 2‑79** | N/A |  |
| PDF | Gas peak day factor | Lookup in **Table 2‑79** | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years |  |
| RUL | Remaining useful life | See Measure Life section | Years |  |

**Table 2‑78 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 2‑79 Peak Factors**

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Cooling coincidence factor (CFc) | 0.69 | [110] |
| Pump coincidence factor (CFpump) | If unit runs continuously all year, CF=1.0, else use 0.5 | [112] |
| Natural gas peak day factor (PDF) | See Appendix G |  |

***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 2‑80 Measure Life**

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Water source Pump | 15 | 5 | [104] |
| Ground source heat pump | 25 | 8.33 | [103] |
| Central A/C | 15 | 5 | [104] |
| Air source heat pump | 15 | 5 | [104] |
| PTAC/PTHP | 15 | 5 | [104] |
| Room air conditioner | 12 | 4 | [91] |
| Fossil fuel furnace | 20 | 6.7 | [104] |
| Electric resistance/electric furnace | 20 | 6.7 | [104][552] |

***References***

1. VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.
2. VEIC estimate. Extrapolation of manufacturer data.
3. From NY TRM V11, pg 278-288
4. *Determining Electric Motor Load and Efficiency*. (DOE, 2014), pg 1, <https://www.energy.gov/sites/prod/files/2014/04/f15/10097517.pdf>
5. ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://xp20.ashrae.org/publicdatabase/system\_service\_life.asp?selected\_system\_type=1
6. 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>
7. 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>
8. 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>
9. *§ 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
10. “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>.
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14. Determining Electric Motor Load and Efficiency. (DOE, 2014), pg 1, <https://www.energy.gov/sites/prod/files/2014/04/f15/10097517.pdf>

### Gas Forced Air and Hydronic Heating

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/NC/EREP |
| Baseline | Code/Dual |
| End Use Subcategory | HVAC Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version | * Revised equation to account for oversizing |

Description

This section provides energy savings algorithms for qualifying furnaces and boilers installed in single family detached and low-rise 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 residential units.

Baseline Case

New construction, time of sale: 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 [113].

Early Replacement: In the case of early replacement of a working unit where the unit would have otherwise continued to function, use dual baselines as described below. This measure assumes the existing equipment is the same fuel type as the installed equipment.

* For the remaining useful life of existing unit: Baseline is the existing equipment of the same fuel type as the installed equipment. If unknown, use the code in force when the equipment was new. If the equipment vintage is unknown, look up the 2013 minimum efficiency from Appendix E.
* For the duration of the measure life after the RUL of the existing equipment: Baseline is a minimally code complient unit as required by IECC 2021.

Efficient Case

Furnace or boiler with an efficiency that meets or exceeds program requireme.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

1

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑81 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Capin | Input capacity of qualifying unit | Site-specific | kBtu/hr |  |
| Effq | Furnace or Boiler Proposed Efficiency | Site-specific | N/A |  |
| Effb | Furnace or Boiler Baseline Efficiency | Site-specific or unknown lookup in Table 2‑82 and Table 2‑83 for single family detached/multifamily low-rise units | N/A | [113] |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Look up in Appendix E | Hrs/yr |  |
| Fos | Oversizing factor to account for baseline efficiency degradation when equipment is oversized more than the standard assumption | 0.9 | N/A | [116] |
| 100 | Conversion factor | 100 | kBtu/Therms |  |
| EUL | Effective useful life of furnace or boiler | See Measure Life section | years | [114] |
| RUL | Remaining useful life | See Measure Life section | years | [114] |
| PDF | Gas peak day factor | Lookup in Table 2‑84 | N/A |  |

Table 2‑82 Baseline AFUE of Single Family and Low-Rise Multifamily Furnaces

|  |  |  |  |
| --- | --- | --- | --- |
| Product Class | AFUE | Compliance Date | AFUE (Manufactured before compliance Date) |
| Weatherized gas furnaces | 0.81 | January 1, 2015. | 0.78 |
| Non-weatherized gas furnaces (not including mobile home furnaces) | 0.80 | November 19, 2015. | 0.78 |
| Weatherized oil-fired furnaces | 0.78 | January 1, 1992. | 0.78 |
| Non-weatherized oil-fired furnaces (not including mobile home furnaces) | 0.83 | May 1, 2013. | 0.78 |
| Mobile Home gas furnaces | 0.80 | November 19, 2015. | 0.75 |
| Mobile Home oil-fired furnaces | 0.75 | September 1, 1990. | 0.75 |

Table 2‑83 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 |

Peak Factors

Table 2‑84 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Natural gas peak day factor (PDF) | Look up in Appendix G |  |

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 2‑85 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | New construction EUL | Retrofit RUL | Ref |
| Furnace | 20 | 6.7 | [115] |
| Boiler | 20 | 6.7 | [115] |

References

1. 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)>
2. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
3. California eTRM, CPUC Support Tables: Effective Useful Life and Remaining Useful Life <https://www.caetrm.com/cpuc/table/effusefullife/>
4. Placeholder assumption based on NREL simulation model relationships between efficiency and part load ratio

### High Efficiency Bathroom Exhaust Fan

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/DI/EREP |
| Baseline | Existing |
| End Use | Ventilation Fan |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑86 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| CFM | Nominal Capacity of the exhaust fan | Site-specific, if unknown use 20 CFM | CFM | [117] |
| Effb | Average efficacy for baseline fan | Site-specific, if unknown use 3.1 CFM/watt | CFM/watt | [118] |
| Effq | Average efficacy for efficient fan | Site-specific, if unknown use 8.3 CFM/watt | CFM/watt | [119] |
| Hrs | Annual hours of operation | 8,760 | Hrs/yr |  |
| CF | Electric coincidence factor | Lookup in Table 3‑152 | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Peak Factors

Table 2‑87 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1 |  |

Measure Life

The effective useful life (EUL) is 19 years [120].

References

1. 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
2. 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
3. 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
4. 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>

### 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:

Where,

Fans:

Annual Fuel Savings

Peak Demand Savings

Pumps:

Fans:

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑88 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Annual peak electric demand savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhfan | Annual energy savings per fan motor | Look up in Table 2‑90 | kWh/unit | [121] [122] |
| ΔkWfan | Electric demand savings per fan motor | Central A/C: 0.116 No Central A/C: 0  Unknown: 0.05[[33]](#footnote-35) | kW/unit | [122] |
| hp | Efficient circulator motor horsepower | Site-specific | HP |  |
| Effb | Baseline motor efficiency | Site-specific, if unknown look up in Table 2‑89 | N/A | [124] |
| Effq | Efficient motor efficiency | Site-specific, if unknown look up in Table 2‑89 | N/A | [124] |
| LF | Motor load Factor | 0.9 | N/A | [123] [125] |
| hrsh | Operating hours during the heating season | 3,504 | hrs/yr | [125] |
| hrsc | Operating hours during the cooling season[[34]](#footnote-36) | 2,208 | hrs/yr | [125] |
| hrs | Total operating hours | 5,712 | hrs/yr |  |
| 0.746 | Conversion factor for HP to kWh | 0.746 | kW/HP |  |
| CFfan | Electric coincidence factor fan | Look up in Table 2‑91 | N/A |  |
| CFpump | Electric coincidence factor pump | Look up in Table 2‑91 | N/A |  |
| EUL | Effective Useful Life | See  Measure Life Section | Years |  |
| RUL | Remaining Useful Life | See  Measure Life Section | Years |  |

Table 2‑89 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 2‑90 Annual Fan Energy Savings

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Climate Region | Annual Energy Saved (ΔkWhfan) | | | | | HDD | CDD |
| **Total with Central AC** | **Total without Central AC** | **Circulation Mode** | **Heating Mode** | **Cooling Mode** |
| North | 435 | 323 | 211 | 112 | 112 | 6,136 | 934 |
| Coastal | 404 | 298 | 211 | 87 | 106 | 4,795 | 886 |
| Central | 434 | 313 | 211 | 102 | 121 | 5,588 | 1,008 |
| Pine barrens | 425 | 312 | 211 | 101 | 113 | 5,529 | 945 |
| Southwest | 440 | 314 | 211 | 103 | 126 | 5,658 | 1,048 |
| Statewide Average | 429 | 312 | 211 | 101 | 117 | 5,553 | 973 |

\*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 2‑91 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Fan coincidence factor (CFfan) | 0.68 | [122] |
| Pump coincidence factor (CFpump) | 0.8 | [126] |
| 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

1. ONJSC: Monthly/Annual Temperature Normals (1991-2020). <http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html>
2. 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.
3. US DOE, *Evaluation of Retrofit Variable-Speed Furnace Fan Motors*, January 2014. <https://www.nrel.gov/docs/fy14osti/60760.pdf>
4. 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
5. M Samotyj, *Assessment of New Energy Efficient Circulator Pump Technology*. (EPRI, 2010), Pg 4-3, <https://www.epri.com/research/products/1020132>
6. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs V9*. (New York State Joint Utilities, 2021), Pg 211, [techni[technical-resource-manual-version-9-filed-october-27-2021-effective-january-1-2022.pdf (ny.gov)](https://dps.ny.gov/system/files/documents/2022/11/technical-resource-manual-version-9-filed-october-27-2021-effective-january-1-2022.pdf)cal-resource-manual-version-9-filed-october-27-2021-effective-january-1-2022.pdf (ny.gov)](https://dnv.sharepoint.com/teams/NewJerseyEEEval/Shared%20Documents/TRM%20Comprehensive%20Update/Draft%20TRM/technical-resource-manual-version-9-filed-october-27-2021-effective-january-1-2022.pdf%20(ny.gov))

### Duct Sealing and Duct Insulation

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Category | HVAC |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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” [127], which are summarized in

Table 2‑93 and Table 2‑94 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 2‑94 that match the duct system, and if the majority of the duct system is in conditioned space add the matching value fromTable 2‑95, 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

**Calculate electric savings for cooling equipment and/or electric heating equipment, if applicable.**

Methodology 1: Evaluation of distribution efficiency

Where,

Methodology 2: RESNET Test 803.7

Where,

Annual Fuel Savings

**Calculate fuel savings for fuel heating equipment, if applicable.**

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑92 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhcooling | Annual electric energy savings, cooling | Calculated | kWh/yr |  |
| ΔkWhheating | Annual electric energy savings, heating | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Capcool | Capacity of air cooling system | Site-specific | kBtu/hr |  |
| Capheat | Capacity of air heating system | Site-specific | kBtu/hr |  |
| CFM25B | Standard duct leakage test result at 25 Pascal pressure differential of the duct system prior to sealing | Site-specific | CFM |  |
| CFM25Q | 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 2‑95 | Btu/W·hr | [127] |
| HSPF | Heating seasonal performance factor | Site-specific, if unknown look up in Table 2‑95 | Btu/W·hr | [127] |
| DEpost | Distribution efficiency after duct sealing and insulation | Look up in  Table 2‑93. For conditioned area, look up adder in Table 2‑94 | N/A | [128] |
| DEpre | Distribution efficiency before duct sealing and insulation | Look up in  Table 2‑93. For conditioned area, look up adder in Table 2‑94 | N/A | [128] |
| AFUE | Annual fuel utilization efficiency | Look up in  Table 2‑96 | N/A | [127] |
| EFLHcool | Cooling equivalent full load hours | Lookup in Appendix C: Heating and Cooling EFLH | Hrs |  |
| EFLHheat | Heating equivalent full load hours | Lookup in Appendix C: Heating and Cooling EFLH | Hrs |  |
| 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 2‑97 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑97 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑93 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 2‑94 below to DEpre and DEpost determined from

Table 2‑93, 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 2‑94 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 2‑95 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 2‑96 AFUE Values

|  |  |  |
| --- | --- | --- |
| Product Class | Efficiency Value | Efficiency Unit |
| Non-weatherized gas furnaces | 0.80 | AFUE |
| Mobile home gas furnaces | 0.80 | AFUE |
| Non-weatherized oil-fired furnaces | 0.83 | AFUE |
| Mobile home oil-fired furnaces | 0.75 | AFUE |
| Weatherized gas furnaces | 0.81 | AFUE |
| Weatherized oil-fired furnaces | 0.78 | AFUE |
| Electric furnaces | 3.412 | HSPF |

Peak Factors

Table 2‑97 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [129] |
| 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 2‑98 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Duct Sealing & Duct Insulation | 15 | 5 | [131] |

References

1. 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>
2. Building Performance Institute, Duct Efficiency Tables, <http://www.bpi.org/files/pdf/DistributionEfficiencyTable-BlueSheet.pdf>
3. BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.
4. 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>
5. 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>

### 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

Cooling energy savings:

For ERVs:

For HRVs:

Heating energy savings (both ERVs and HRVs):

Fan energy savings:

Annual Fuel Savings

Summer Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑99 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhc | Annual electric energy savings during cooling season | Calculated | kWh |  |
| ΔkWhh | Annual electric energy savings during heating season | Calculated | kWh |  |
| ΔkWhfan | Annual electric energy savings due to fan operation | Calculated | kWh |  |
| CFM | Flow rate of supply air passing through ERV/HRV | Site-specific | Ft3/min |  |
| (cfm/watt)b | Baseline ERV/HRV fan efficacy | Look up in Table 2‑103 | cfm/watt | [138] |
| (cfm/watt)q | Efficient ERV/HRV fan efficacy | Site-specific | cfm/watt |  |
| Effhx,total | Total effectiveness of heat exchanger per rating in accordance with AHRI Standard 1060 | Site-specific | N/A | [132] |
| Effhx,sens | Sensible effectiveness of heat exchanger per rating in accordance with AHRI Standard | Site-specific, if unknown use 0.65 | N/A | [138] |
| 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[[35]](#footnote-37) | 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[[36]](#footnote-38) | Site-specific, if unknown lookup in Appendix E: Code-Compliant Efficiencies for equipment type and size | Btu/watt-hour |  |
| 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 |  |
| Tindoor,h | Indoor heating setpoint temperature | Site-specific, if unknown use 70 | °F |  |
| Tindoor,c | Indoor cooling setpoint temperature | Site-specific, if unknown use 70 | °F |  |
| Hindoor | Enthalphy of indoor air | Lookup in Table 2‑100 based on Tindoor | Btu/lb |  |
| HP | Total fan horsepower | Site-specific | HP |  |
| LF | Load factor | Site-specific, if unknown use 0.92 | N/A | [137] |
| hrsc | Operating hours in the cooling season | Look up in Table 2‑100 | hrs | [135] |
| hrsh | Operating hours in the heating season | Look up in Table 2‑100 | hrs | [135] |
| Toutdoor,c | Temperature of outside air during cooling | Look up in Table 2‑101 | Btu/lb | [136] |
| Toutdoor,h | Temperature of outside air during heating | Look up in Table 2‑101 | Btu/lb | [136] |
| Toutdoor,c,peak | Peak outdoor temperature during cooling season | Look up in Table 2‑104 | °F | [139] |
| Houtdoor,c,peak | Peak Enthalpy of outdoor air during cooling season | Look up in Table 2‑104 | °F | [139] |
| Houtdoor,c | Enthalpy of outside air during cooling | Lookup in Table 2‑101 | Btu/lb | [136] |
| FElecHeat | Electric heating factor, to account for presence of electric heat | Use 1 if electric heat, otherwise use 0 | N/A |  |
| FFuelHeat | 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/ft3.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 2‑105 | N/A | [133] |
| PDF | Gas peak day factor | Look up in Table 2‑105 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑100 Indoor Enthalpy

|  |  |
| --- | --- |
| Temperature, Tindoor (°F) | Enthalpy, Hindoor 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 |
| 73 | 27.0 |
| 74 | 27.5 |
| 75 | 28.1 |
| 76 | 28.7 |
| 77 | 29.3 |
| 78 | 29.9 |

Table 2‑101 Heating and Cooling Hours[[37]](#footnote-39)

|  |  |  |
| --- | --- | --- |
| NJ Climate Region | Heating Hours, hrsh | Cooling Hours, hrsc |
| 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 2‑102 Outdoor Air Temperature and Enthalpy

|  |  |  |  |
| --- | --- | --- | --- |
| NJ Climate Region | Avg. outdoor temperature during cooling season, Toutdoor,c (°F) | Avg. outdoor temperature during heating season, Toutdoor,h (°F) | Avg. enthalpy[[38]](#footnote-40) of outdoor air at duing cooling season, Houtdoor,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 |
| Statewide Average | 74.1 | 43.5 | 25.1 |

Table 2‑103 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 2‑104 Peak Outdoor Air Temperature and Enthalpy

|  |  |  |
| --- | --- | --- |
| NJ Climate Region | Peak outdoor temperature during cooling season, Toutdoor,c,peak (°F) | Peak Enthalpy of outdoor air at duing cooling season, Houtdoor,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 2‑105 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [133] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 14 years [134].

References

1. Performance Rating of air-to-air exchanges for Energy Recovery Ventilation Equipment, AHRI, December 2022. <http://www.ahrinet.org/ERVcertification>
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### 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

Where,

For geothermal heat pumps:

For PTAC and PTHP:

Annual Fuel Savings

Peak Demand Savings

For geothermal heat pumps:

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑106 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhc | Annual electric cooling energy savings | Calculated | kWh/yr |  |
| ΔkWhh | Annual electric heating energy savings | Calculated | kWh/yr |  |
| SSEb | Steady state efficiency of baseline gas HVAC equipment | Site-specific | N/A |  |
| SSEq | Steady state efficiency of repaired gas HVAC equipment | Site-specific | N/A |  |
| Capc | Cooling Capacity of electrical unit receiving tune-up | Site-specific | kBtu/hr |  |
| Caph | Heating Capacity of electrical unit receiving tune-up | Site-specific | kBtu/hr |  |
| Capin | 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 | [143] |
| EERg | 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 | [143] |
| COPg | 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 | [143] |
| SF | Savings factor, assumed savings due completion of tune up[[39]](#footnote-41) | 0.05 | N/A | [149] |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [140] |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season[[40]](#footnote-42) | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [142] |
| GSER | Factor used to determine the SEER of a GSHP based on its EERg | 1.02 | Btu/W-h |  |
| GSPK | Factor to convert EERg 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 2‑107 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑107 | N/A |  |
| EUL | Estimated useful life | Look up in Table 2‑108 | Years |  |
| 100 | Conversion from kBtu to therms | 100 | kBtu/Therms |  |

Peak Factors

Table 2‑107 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [141] |
| 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 2‑108 Measure Life

|  |  |  |
| --- | --- | --- |
| Equipment | EUL | Ref |
| Air Conditioner – Room (RAC) | 12 | [144] |
| Air Conditioner – Central (CAC) | 15 | [145] |
| Air Conditioner – PTAC | 15 | [145] |
| Boiler, Hot Water – Steel Water Tube | 24 | [146] |
| Boiler, Hot Water – Steel Fire Tube | 25 | [146] |
| Boiler, Hot Water – Cast Iron | 35 | [146] |
| Boiler, Steam – Steel Water Tube | 30 | [146] |
| Boiler, Steam – Steel Fire Tube | 25 | [146] |
| Boiler, Steam – Cast Iron | 30 | [146] |
| Furnace, Gas Fired | 22 | [147] |
| Gas Heat Pump | 15 | [145] |
| Heat Pump - Air Source (ASHP) | 15 | [145] |
| Heat Pump – Ground Source (GSHP) | 25 | [148] |
| Heat Pump – PTHP | 15 | [145] |
| Ductless Mini-Split | 15 | [150] |

References

1. NJ utility analysis of heating customers, annual gas usage.
2. NEEP, *Mid-Atlantic Technical Reference Manual*, *V10* (May 2020).
3. VEIC estimate.
4. 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>
5. GDS Associates, Inc*., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures* (June 2007) Table 1 – Residential Measures.
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7. ASHRAE Handbook, 2015.
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9. ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey. <https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1>
10. *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>
11. 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>

### Boiler Controls

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use | HVAC |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑109 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| Capin | Input capacity of boiler | Site specific. If unknown, use 117 | kBtu/hr | [156] |
| SF | Savings factor, estimated percent reduction in heating load due to controls being installed. | 0.05 | N/A | [151] |
| EFLHh | Estimated full load hours for heating | Lookup in Appendix C: Heating and Cooling EFLH | hrs | [152] |
| EUL | Effective useful life | Lookup in Table 2‑111 | Years |  |
| PDF | Peak day factor | Lookup in Table 2‑110 |  |  |
| 100 | Conversion from kBtu to therm | 100 | kBtu |  |

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

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 2‑111 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Boiler, Hot Water – Steel Water Tube | 24 | 8 | [153] |
| Boiler, Hot Water – Steel Fire Tube | 25 | 8.33 | [557] |
| Boiler, Hot Water – Cast Iron | 35 | 11.67 | [557] |
| Boiler, Steam – Steel Water Tube | 30 | 10 | [557] |
| Boiler, Steam – Steel Fire Tube | 25 | 8.33 | [557] |
| Boiler, Steam – Cast Iron | 30 | 10 | [557] |

References

1. 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>
2. Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.
3. ASHRAE Handbook, 2015.
4. ETG PY2 Impact Evaluation

### Filter Whistle

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Filter Whistle |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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

*Where,*

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑112 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔkWhh | Annual heating electric energy savings | Calculated | kWh/yr |  |
| ΔkWhc | Annual cooling electric energy savings | Calculated | kWh/yr |  |
| kWmotor | 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[[41]](#footnote-43) | HP |  |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [155] |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [156] |
| EI | Efficiency Improvement | 15% | N/A | [157] |
| 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 | [158] |
| CF | Electric coincidence factor | Look up in Table 2‑113 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 2‑113 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [160] |
| 0.746 | Conversion factor for HP to kWh | 0.746 | kW/HP |  |

Peak Factors

Table 2‑113 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [159] |
| 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 2‑114 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Filter Whistle | 5 | 1.67 | [160] |

References

1. NJ utility analysis of heating customers, annual gas usage
2. VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI.
3. 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>
4. 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>
5. 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."
6. DEER 2020 <http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx>

### Ceiling Fan

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/DI |
| Baseline | Existing/Dual |
| End Use Subcategory | Ceiling Fan |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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 [161].

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

TOS: Code compliant ceiling fan/light unit with EISA qualified incandescent or halogen light bulbs.

DI: Use dual baseline. The baseline equipment for the first baseline period is the site-specific existing fan . The baseline equipment for the second baseline period is a code-compliant fan/light weith 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

Where,

Annual Fuel Savings

If fan is located in unconditioned/exterior space:

Heating penalty from improved lighting, if fan is located in heated space:

Peak Demand Savings

Where,

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑115 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhfan | Annual ceiling fan savings | Calculated | kWh/yr |  |
| ΔkWhlight | Annual light savings | Calculated | kWh/yr |  |
| ΔkWfan | Annual fan peak demand savings | Calculated | kW |  |
| ΔkWlight | Annual light peak demand savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Days | Days used per year | Site-specific, if unknown use 365 | Days/yr | [164] |
| Hrsfan | Daily Fan “On Hours” | Site-specific, if unknown use 3 | Hrs/day | [164] |
| Wlow,b | Fan wattage at Low speed of baseline | TOS: 15  DI: Site-specific, if unknown use 15 | Watts | [164] |
| Wmed,b | Fan wattage at Medium speed of baseline | TOS: 34  DI: Site-specific, if unknown use 34 | Watts | [164] |
| Whigh,b | Fan wattage at High speed of baseline | TOS: 67  DI: Site-specific, if unknown use 67 | Watts | [164] |
| Wlow,q | Fan wattage at Low speed of ENERGY STAR | TOS: 6  DI: Site-specific, if unknown use 6 | Watts | [164] |
| Wmed,q | Fan wattage at Medium speed of ENERGY STAR | TOS: 23  DI: Site-specific, if unknown use 23 | Watts | [164] |
| Whigh,q | Fan wattage at High speed of ENERGY STAR | TOS: 56  DI: Site-specific, if unknown use 56 | Watts | [164] |
| Wb,light | Total lighting wattage of baseline fixture | TOS: 129  DI: Site-specific, if unknown use 129 | Watts | [164] |
| Wq,light | Total lighting wattage of energy efficient fixture | TOS: 42  DI: Site-specific, if unknown use 42 | Watts | [164] |
| FFH | Fraction of homes using fossil fuel heat | Look up in Appendix K: DHW and Space Heat Fuel Split | N/A |  |
| Flow,b | Fraction of time spent at Low speed of baseline | 0.4 | N/A | [164] |
| Fmed,b | Fraction of time spent at Medium speed of baseline | 0.4 | N/A | [164] |
| Fhigh,b | Fraction of time spent at High speed of baseline | 0.2 | N/A | [164] |
| Flow,q | Fraction of time spent at Low speed of ENERGY STAR | 0.4 | N/A | [164] |
| Fmed,q | Fraction of time spent at Medium speed of ENERGY STAR | 0.4 | N/A | [164] |
| Fhigh,q | Fraction of time spent at High speed of ENERGY STAR | 0.2 | N/A | [164] |
| 1,000 | Conversion from W to kW | 1,000 | W/kW |  |
| Hrslight | Lighting hours of operation | Look up in Table 2‑116 | Hrs/yr | [162][163] |
| HVACe | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [162] |
| HVACd | HVAC Interactive Factor for Peak Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [162] |
| HF | Heating Factor | 0.47 | N/A |  |
| Effheat | Efficiency of heating system | 0.8 | N/A |  |
| CF | Electric coincidence factor | Look up in Table 2‑117 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 2‑117 | 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 2‑116 Lighting Hours

|  |  |
| --- | --- |
| Installation Location | Hrs |
| Interior | 679 |
| Exterior | 1643 |
| Unknown | 808 |

Peak Factors

Table 2‑117 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Fan coincidence factor (CFfan) | 0.3 | [165] |
| Light coincidence factor (CFlight) | 0.06 | [162] |
| Natural gas peak day factor (PDF) | N/A | 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 2‑118 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Ceiling Fan | 15 | 5 | [162] |

References

1. “Ceiling Fans.” n.d. Www.energystar.gov. https://www.energystar.gov/products/ceiling\_fans.
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3. ‌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>
4. ‌ <https://www.energystar.gov/sites/default/files/asset/document/light_fixture_ceiling_fan_calculator.xlsx>
5. 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

### Smart Thermostat

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF/TOS |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

Description

This measure covers the installation of Smart or Connected ENERGY STAR® V1.0[[42]](#footnote-44) thermostats applied to single-family and multifamily residential HVAC systems. A “smart” thermostat that is ENERGY STAR® certified has the following properties [168].

* 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. In 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.

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

*Where,*

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑119 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated  For Online Marketplace or Midstream delivery, look up in Table 2‑119 | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhcool | Cooling electric savings | Calculated | kWh/yr |  |
| ΔkWhheat | Heating electric savings | Calculated | kWh/yr |  |
| Capc | Cooling capacity per residence | Site-specific,  if unknown use 36 kBTU/hr[[43]](#footnote-45) | kBtu/hr | [173] |
| SEER2 | Seasonal energy efficiency ratio of cooling unit | Site-specific, if unknown, look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [166] |
| EFLHcool | Equivalent full load hours of operation during cooling season | Look up in Appendix C: Heating and Cooling EFLH | Hours | [167] |
| SFelec,c | Cooling energy savings factor | 0.07 | N/A | [171] |
| FelecCool | 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 | [169] |
| Caph,out | Output heating capacity in kBTU/h per residence | Site-specific,  if unknown use 72 kBtu/hr[[44]](#footnote-46) | kBtu/hr | [173] |
| Caph,fuel | Heating capacity in of existing fossil heat unit | Site-specific, if unknown use 90 kBtu/hr[[45]](#footnote-47) | kBtu/hr | [173] |
| 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 | [166] |
| EFLHheat | Equivalent full load hours of operation during heating season | Look up in Appendix C: Heating and Cooling EFLH | Hours | [167] |
| AFUE | Annual fuel utilization efficiency | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | N/A | [166] |
| SFfuel | Fuel heating energy savings factor | 0.06 | N/A | [171] |
| SFelec,h | Electric heating energy savings factor | 0.06 | N/A | [171] |
| FelecHeat | 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 | [170] |
| FFuelHeat | 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 | [170] |
| 100 | Conversion factor, kBTU to therms | 100 | kBTU/therms |  |
| 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 Measure Life Section | Years |  |
| ISR | In-service rate | Lookup in Appendix J. Default is 1.0 | N/A |  |

Table 2‑120 Deemed Savings for Online Marketplace Smart Thermostats

|  |  |  |  |
| --- | --- | --- | --- |
| CEF-II Equipment Combinations | ∆kWh | ∆kW | ∆Therms |
| Boiler and No Cooling | 0 | - | 62.0357 |
| Furnace (Non-Weatherized) and No Cooling | 0 | - | 65.1375 |
| Electric Resistance | 1,221.805 | - | 0 |
| CAC, No Heating | 160.603 | - | 0 |
| CAC, Boiler | 160.603 | - | 62.0357 |
| CAC, Furnace (Non-Weatherized) | 160.603 | - | 65.1375 |
| CAC, Electric Resistance | 1,382.408 | - | 0 |
| ASHP - Split | 706.3351 | - | 0 |
| ASHP - Package | 782.8119 | - | 0 |

Peak Factors

Table 2‑121 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 5 years [172].

References

1. “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>
2. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
3. *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>
4. 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).
5. 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).
6. *TRM Mid-Atlantic Technical Reference Manual:Version 10* (NEEP, 2020), Pg 104, <https://neep.org/mid-atlantic-technical-reference-manual-trm-v10>
7. 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>
8. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 10, Pg 308

## Lighting

### Lamps and Fixtures

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | TOS/NC/RF/EREP/ERET/DI |
| Baseline | Existing/Code |
| End Use Subcategory | Lighting |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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[181]. Full compliance with this standard by retailers shall commence on August 1, 2023[180].

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 2‑123, Table 2‑124, and Table 2‑125.

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:

Where,

Nightlights:

Holiday Lights:

Where,

Annual Fuel Savings

ENERGY STAR Lamps and Fixtures:

No fuel savings associated with Nightlights and Holiday Lights.

Peak Demand Savings

ENERGY STAR Lamps and Fixtures:

No Peak Demand Savings associated with Nightlights and Holiday Lights.

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑122 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔthermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| Nq | Quantity of energy efficient fixtures | Site-specifc | N/A |  |
| Wb,ES | Wattage of baseline fixture | EISA Compliant: Calculated based on algorithm above  Exempt from EISA Compliance: Site-specific, if unkown look up in Table 2‑123, Table 2‑124, Table 2‑125 | kW | [184] |
| Wq,ES | Wattage of energy efficient fixture | Site-specifc | kW |  |
| Lumensq | Lumens of energy efficient fixture | Site-specific | Lumens |  |
| Fmini | Percentage of holiday lights that are “mini” | Site-specific, if unknown use 0.5 | % | [178] |
| FC7 | Percentage of holiday lights that are “C7” | Site-specific, if unknown use 0.25 | % | [178] |
| FC9 | Percentage of holiday lights that are “C9” | Site-specific, if unknown use 0.25 | % | [178] |
| Nbulbs | Number of bulbs per strand | Site-specific, if unknown use 50 | Bulbs/Strand | [179] |
| Nstrands | Number of strands of lights per package | Site-specific, if unknown use 1 | Strands/package | [179] |
| HrsES | Annual Hours of Operation | Site-specific, if unknown use 679 | Hrs/yr | [174] |
| HVACc | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [174] |
| HVACd | HVAC Interactive Factor for Peak Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [174] |
| HVACff | Heating factor, or percentage of lighting savings that must be heated | Look up in Appendix F: HVAC Interactivity Factors | N/A | [174] |
| ISR | In-service rate | Look up by program in Appendix J: In-Service Rates, or use default value = 0.92 | N/A | [187] |
|  | Efficiency of heating system | 0.8 | N/A | [183] |
| FFH | Fraction of homes using fossil fuel heat | 0.8 | N/A | [182] |
| WNL | Average watts replaced for an LED nightlight installation | 6.75 | W | [176] |
| HrsNL,daily | Average daily burn time for LED nightlight replacements | 12 | hrs | [177] |
| 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 |  |
| Wq,mini | Wattage of LED mini bulbs | 0.08 | W/Bulb | [178] |
| Wb,mini | Wattage of incandescent mini bulbs | 0.48 | W/Bulb | [178] |
| Wq,C7 | Wattage of LED C7 bulbs | 0.48 | W/Bulb | [178] |
| Wb,C7 | Wattage of incandescent C7 bulbs | 6 | W/Bulb | [178] |
| Wq,C9 | Wattage of LED C9 bulbs | 2 | W/Bulb | [178] |
| Wb,C9 | Wattage of incandescent C9 bulbs | 7 | W/Bulb | [178] |
| 45 | Conversion from lumens of energy efficient fixture to wattage of baseline fixture | 45 | Lumens/watt |  |
| HrsHL | Annual hours of operation for Holiday Lights | 150 | Hrs/yr | [178] |
| CF | Electric coincidence factor | Look up in Table 2‑126 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑126 | N/A |  |
| EUL | Effective useful life (use AML for EREP/DI, use EUL for TOS/NC per Measure Life Section) | See Measure Life Section | Years |  |

Table 2‑123 Exempt Standard Lamp Baselines

|  |  |  |
| --- | --- | --- |
| Bulb Type | Lumen Range | Wb,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 2‑124 Exempt Specialty Lamps Baseline

|  |  |  |  |
| --- | --- | --- | --- |
| Bulb Type | Base Type | Lumen Range | Wb,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 |
| > 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 |
| 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 2‑125 Exempt Reflector/Flood Lamps Baseline

|  |  |  |
| --- | --- | --- |
| Bulb Type | Lumen Range | Wb,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 |
| > 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 |
| 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 2‑126 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.06 | [174] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

Table 2‑127 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | AML (for EREP/DI) | EUL (for NC/TOS) | Ref |
| Lamps and Fixtures | 4 | 15 | [185][186][188] |

References

1. “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> .
2. ‌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>
3. Jackie Berger, *NJ Comfort Partners Energy Saving Protocols and Engineering Estimates*. (Applied Public Policy Research Institute for Study and Evaluation (APPRISE), 2014), Pg 21, <https://www.njcleanenergy.com/files/file/Protocol%20and%20Engineering%20Estimate%20Summary.pdf> .
4. *Southern California Edison Company, LED,Electroluminescent & Fluorescent Night Lights: Work Paper WPSCRELG0029 Rev.1,* (February 2009), pp. 2–3
5. The DSMore Michigan Database of Energy Efficiency Measures: Based on spreadsheet calculations using collected data
6. Typical values of lights per strand and strands per package at Home Depot and other stores
7. “Regulations.gov.” n.d. Www.regulations.gov. Accessed December 1, 2022. https://www.regulations.gov/document/EERE-2021-BT-STD-0012-0022.
8. “New Jersey A5160 | 2020-2021 | Regular Session.” n.d. LegiScan. Accessed December 1, 2022. https://legiscan.com/NJ/bill/A5160/2020.

1. <https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430#430.32>
2. ‌Based on RECS 2015 data for Middle Atlantic Region (Table HC6.7).
3. 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>
4. ‌ 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>
5. 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>
6. 2021 Pennsylvania TRM, Volume 2, Residential Measures, <http://www.puc.pa.gov/pcdocs>
7. Residential AML value based on analysis conducted in Maryland. Reference: Recommended Estimated Useful Life Assumptions for the EmPOWER Upstream Lighting Programs, Joint Recommendation, PSC Staff, PSC Independent Evaluator, Office of Peoples Counsel, Maryland Energy Administration and EmPOWER Electric Utilities, Case No. 9648.

### Occupancy Sensor

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF/TOS |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑128 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Wq | Total wattage of the fixture(s) being controlled by the occupancy sensor | Site specific, if unknown assume 105.5 | W | [200] |
| SVGe | Percentage of annual lighting energy saved by lighting control | Site-specific, if unknown assume 49% | % | [193] |
| ISR | In service rate or percentage of units rebated that get installed | Site-specific, if unknown use default = 0.98 | N/A | [194] |
| Hrs | Average hours of use per year | Look up in | Hours | [189][190][191][192] |
| HVACc | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [192] |
| HVACff | HVAC Interactive Factor for Annual Fuel Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [192] |
| HVACd | HVAC Interactive Factor for Peak Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [192] |
| 1000 | Unit Conversion, kW/Watts | 1,000 | kW/W |  |
| CF | Electric coincidence factor | Look up in Table 2‑130 Peak Factors | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑130 Peak Factors | N/A |  |
| EUL | Effective useful life (use AML for EREP/DI, use EUL for TOS/NC per Measure Life Section) | See Measure Life Section | Years |  |

Table 2‑129 Hours

|  |  |
| --- | --- |
| Installation Location | Annual Hours |
| Residential interior & in-unit Multi Family | 679 |
| Multi Family Common Areas | 5,950 |
| Unknown | 679 |

Peak Factors

Table 2‑130 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | Lookup in Table 2‑131 | [196][197][198] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Table 2‑131 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 |
| 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

Table 2‑132 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | AML (for EREP/DI) | EUL (for NC/TOS) | Ref |
| Lamps and Fixtures | 4 | 15 | [201][202][203] |

References

1. 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.
2. 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.
3. Unknown” assumes a residential interior or in-unit multifamily application.
4. “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>

1. 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 71% 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.
2. 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
3. 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.
4. Based on Navigant Consulting “EmPOWER Residential Lighting Program: 2016 Residential Lighting Inventory and Hours of Use Study” August 31, 2017, page 15
5. Consistent with value currently used for EmPOWER Maryland Programs as of October 1, 2017. Derived from C&I common area lighting coincidence.
6. Calculated from Itron eShapes, which is 8760 hourly data by end use for Upstate New York.
7. 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>.
8. 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
9. ‌ 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>
10. 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>
11. Residential AML value based on analysis conducted in Maryland. Reference: Recommended Estimated Useful Life Assumptions for the EmPOWER Upstream Lighting Programs, Joint Recommendation, PSC Staff, PSC Independent Evaluator, Office of Peoples Counsel, Maryland Energy Administration and EmPOWER Electric Utilities, Case No. 9648.

## Plug Load

### 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 [204].

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 [205] and used in a residential setting.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑133 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Lookup in Table 2‑134 | kWh/yr | [204] |
| ΔkWPeak | Peak Demand Savings | Lookup in Table 2‑134 | kW | [204] |
| ΔkWLife | Lifetime electric energy savings | Calculated | kWh |  |

Table 2‑134 Office Equipment Energy and Demand Savings Values per Unit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Measure | | Energy Savings (kWh) | Demand Savings (kW) | Source |
| **Computer (Desktop)** | | 119 | 0.0161 | [204] |
| **Computer (Laptop)** | | 22 | 0.0030 | [204] |
| **Printer (laser, monochrome)** | ≤ 5 images/min | 37 | 0.0050 | [204] |
| 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 | [204] |
| **Multifunction Device (laser, monochrome)** | ≤ 5 images/min | 57 | 0.0077 | [204] |
| 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 | [204] |
| **Monitor** | | 8 | 0.0032 | [204] |

Peak Factors

Peak savings are incorporated in the demand savings values above.

Measure Life

The measure life for residential office equipment is 5 years [206].

References

1. 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.”
2. [ENERGY STAR Computers Final Version 8.0 Specification Rev. July 2022](https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Computers%20Version%208.0%20Final%20Specification%20Rev.%20July%202022.pdf)
3. 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/>

### Televisions

|  |  |
| --- | --- |
| Market | Residential/multifamily |
| Baseline Type | TOS |
| Baseline | Code |
| End Use Subcategory | Electronics |
| Measure Last Reviewed | December 2022 |

s

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑135 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWhb | Annual electric energy savings for baseline case | Look up in Table 2‑136 | kWh/yr | [207][208] |
| kWhq | Peak Demand Savings for efficient case | Look up in Table 2‑136 | kWh/yr | [207][209] |
| kWb | Peak Demand Savings for baseline case | Look up in Table 2‑137 | kW | [207][208] |
| kWq | Annual electric energy savings for efficient case | Look up in Table 2‑137 | kW | [207][209] |
| CF | Coincidence factor | Look up in Table 2‑138 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 2‑138 | N/A |  |
| EUL | Effective useful life of new unit | See Measure Life Section | Years |  |

Table 2‑136 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 |
| 62 | 121.9 | 95.1 |
| 65 | 128.2 | 100.4 |

Table 2‑137 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 2‑138 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF)[[46]](#footnote-48) | 0.21 |  |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The estimated useful life (EUL) is 6 years. [207]

References

1. “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>.
2. ENERGY STAR® Program Requirements for Televisions Eligibility Criteria Version 8.0 <https://www.energystar.gov/sites/default/files/Final%20V8.0%20TVs%20Program%20Requirements.p>df
3. ENERGY STAR® Most Efficient 2020 Recognition Criteria Televsions https://www.energystar.gov/sites/default/files/Televisions%20ENERGY%20STAR%20Most%20Efficient%202020%20Final%20Criteria.pdf

### Smart Strip

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | January 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑139 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | N/A | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | N/A | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Usage | Annual usage of system connected to power strip | Lookup in Table 2‑140 | kWh | [210] |
| ERP | Energy reduction percentage | Lookup in Table 2‑140 | N/A | [210] |
| ISR | In-service rate | Look up by program in Appendix, or use default values in Table 2‑140 | N/A | [210] |
| Load | Demand of system connected to power strip | Lookup in Table 2‑140 | kW | [210] |
| ERPPeak | Energy reduction percentage during peak period | Lookup in Table 2‑140 | N/A | [210] |
| CF | Electric coincidence factor | Look up in Table 2‑141 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 2‑141 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑140 Impact Factors for Advanced Power Strip Types

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Strip Type | End-Use | ERP | ERPPeak | 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 2‑141 Peak Factors

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

Measure Life

Table 2‑142 Measure Life

|  |  |  |
| --- | --- | --- |
| Equipment | EUL | Ref |
| Smart Strip | 5 | [211] |

References

1. 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>
2. California eTRM, CPUC Support Tables: Effective Useful Life and Remaining Useful Life, https://www.caetrm.com/cpuc/table/effusefullife/

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑143 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Units | Number of measures installed during program | Site-specific | N/A |  |
| kWhb | Energy consumption for baseline case | 77 | kWh/yr | [212] |
| kWhq | Efficient unit energy consumption | 29 | kWh/yr | [212] |
| 8,760 | Hours in 1 year | 8,760 | Hours/yr |  |
| CF | Electric coincidence factor | Look up in Table 2‑144 | N/A | [214] |
| PDF | Gas peak demand factor | Look up in Table 2‑144 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [215] |

Peak Factors

Table 2‑144 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [214] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 7 years. [215]

References

1. Pacific Gas and Electric Work Paper PGECOAPP128 Retail Products Platform Revision #2, October 2015, pg 74 http://deeresources.net/workpapers
2. 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
3. Per NY TRM: "No source specified – update pending availability and review of applicable references."
4. 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>

### 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 [216].

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑145 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Hrsps | Annual standby hours plugged in | Calculated | Hours |  |
| Hrsc | Annual active charging hours | Site-specific, if unknown assume 278 | Hours | [220] |
| Hrsp | Total annual hours plugged in | Site-specific, if unknown assume 3,511 | Hours | [220] |
| Hrsus | Annual standby hours unplugged | Site-specific, if unknown assume 5,249 | Hours | [220] |
| Wb | Baslines average standby power | Lookup in Table 2‑146 | W | [217][218] |
| Wq,p | Efficient average standby power with vehicle plugged in | Lookup in Table 2‑146 | W | [219] |
| Wq,u | Efficient average standby power in no vehicle mode | Lookup in Table 2‑146 | W | [219] |
| AvgkW | Average electric demand during standby | Lookup in Table 2‑146 | kW |  |
| CF | Electric coincidence factor | Lookup in Table 2‑147 | N/A |  |
| PDF | Gas peak day factor | Lookup in Table 2‑147 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑146 Standby Power

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Network Type | Wb | Wq,p | Wq,u | kW |
| Non-Networked[[47]](#footnote-49) | 3.7 | 3.5 | 2.1 | 0.00107 |
| Networked48 | 9.9 | 3.2 | 2.5 | 0.00713 |

Peak Factors

Table 2‑147 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 [216].

References

1. 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>
2. 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>
3. INL charger testing <https://avt.inl.gov/evse-type/ac-level-2.html>
4. “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>
5. 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>

### Hedge Trimmers, Leaf Blower, Push Lawnmowers, Chainsaws And Snow Blower

|  |  |
| --- | --- |
| Market | Residential |
| Baseline Condition | TOS |
| Baseline | Existing |
| End Use Subcategory | Landscaping Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version |  |

Description

This is a time of sale measure that applies to the purchase of new residential lawn equipment, which include trimmers, leaf blower, push lawnmowers (not self propelled or ride-on, but contains an electric motor driving the blade), chainsaws, and snow blowers. This measure assumes the offset of converting use of gas lawn equipment to electrical lawn equipment, which in turn saves fossil fuels and increases electric use.

Baseline Case

The baseline equipment is an existing residential gas lawn equipment, which includes trimmers, leaf blower, push lawnmowers, chainsaws, and snow blower.

Efficient Case

The energy efficient equipment must be new residential electric lawn equipment, which includes trimmers, leaf blower, push lawnmowers, chainsaws, and snow blower.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Deemed annual energy savings in Table 2‑150 calculated as follows:

Annual Fuel Savings (Alternate Fuel)

Annual Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings (Alternate Fuel)

Calculation Parameters

Table 2‑148 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Look up in Table 2‑150 | kWh/yr | [221] |
| ΔGalgasoline | Annual gallons gasoline savings | Look up in Table 2‑150 | Gallons | [221] |
| ΔkWPeak | Annual peak electric demand savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔGalLife | Lifetime fuel savings | Calculated | Gallons |  |
| Hrs | Annual operating hours | Look up in Table 2‑149 | Hrs | [221] |
| tcharge | Run time per charge | Look up in Table 2‑149 | Hrs | [223] |
| Ebattery | Rated energy of the battery | Look up in Table 2‑149 | Wh | [223] |
| D | Discharge rate | 0.90 | % | [223] |
| Effcharger | Efficiency of the charger | 0.92 | % | [223] |
| 1,000 | Unit conversion, Wh/kWh | 1,000 | Wh/kWh |  |
| EUL | Effective useful life | See  Measure Life | Years | [221] |

Table 2‑149 Parameters Values

|  |  |  |  |
| --- | --- | --- | --- |
| Type of Electric Equipment | Hrs | tcharge | Ebattery |
| Trimmer | 8.21 | 0.5 | 1HP Replacement: 100  2HP Replacement: 240 |
| Leaf Blower | 9.4 | 0.25 | 1HP Replacement: 100  2HP Replacement: 240 |
| Push Lawnmower | 15 | 1 | 300 |
| Chainsaw | 9.12 | 0.09 | 150 |
| Snow Blower | 8 | 0.75 | 280 |

When calculated using the assumptions above, the energy impacts are equal to the values below. These deemed impacts may be used instead of calculating site-specific savings if reliable input parameters are not available.**Table 2‑150 Deemed Energy Impacts**

|  |  |  |
| --- | --- | --- |
| Type of Electric Equipment | ΔkWhequip | ΔGalgasoline |
| Trimmer | 1HP Replacement: -1.61  2HP Replacement: -3.86 | 1HP Replacement: 1.41  2HP Replacement: 2.35 |
| Leaf Blower | 1HP Replacement: -3.68  2HP Replacement: -8.83 | 1HP Replacement: 1.41  2HP Replacement: 2.35 |
| Push Lawnmower | -4.4 | 3.75 |
| Chainsaw | -14.87 | 1.64 |
| Snow Blower | -2.92 | 8 |

Peak Factors

Table 2‑151 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.5 | [224] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is given in Table 2‑152 [221].

Table 2‑152 Measure Life

|  |  |
| --- | --- |
| Type of Electric Equipment | Measure Life (yrs) |
| Trimmer | 8 |
| Leaf Blower | 8 |
| Push Lawnmower | 10 |
| Chainsaw | 8 |
| Snow Blower | 10 |

References

1. PSEG CEF-EE II Filing 12.1.23
2. Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, EPA 2002
3. PSEG-LI TRM
4. Placeholder assumption until further research conducted.

### Electric Riding Lawn Mower

|  |  |
| --- | --- |
| Market | Residential |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Landscaping Equipment |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

Description

This measure claims savings for the replacement of a gasoline powered ride-on lawnmower with a new all-electric ride-on lawnmower. This measure is characterized for residential applications.

Baseline Case

The baseline condition is assumed to be a gasoline powered ride-on lawnmower.

Efficient Case

The efficient condition is an all-electric ride-on lawnmower.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings (Another Fuel)

Annual Peak Demand Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings (Another Fuel)

Calculation Parameters

Table 2‑153 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings, calculated using the default values below | Calculated (From default value: -72.9) | kWh/yr | [221] |
| ΔGalgasoline | Annual gasoline savings | Calculated (From default value: 36) | gal/yr | [221] |
| ΔkWPeak | Annual peak demand savings | Calculated (From default value: -0.56) | kW/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔGaliGasoline, life | Lifetime gasoline savings | Calculated | gal |  |
| Q | Number of full charges in a year[[48]](#footnote-50) | 32 | N/A | [221] |
| Qtime | Time required to fully charge battery[[49]](#footnote-51) | 4 | Hrs | [221] |
| kWdraw | Demand draw of battery while charging | 0.56 | kW | [221] |
| Nbattery | No of batteries attached to lawn mower | 1 | N/A | [221] |
| U | Annual gasoline consumption | 36 | gallons | [221] |
| CF | Electric coincidence factor | Lookup in Table 2‑154 | N/A |  |
| EUL | Effective useful life | See  Measure Life | Years | [221] |

Peak Factors

Table 2‑154 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.5 | [226] |

Measure Life

The effective useful life (EUL) is 10 years [221].

References

1. Department of Public Services, *2022 Tier III TRM Characterizations*. 2022, Page 56, <https://publicservice.vermont.gov/document/2022-tier-iii-trm-characterizations>
2. Placeholder value until further research conducted.

## Shell

### Residential/Low-rise Multifamily Air Sealing

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Shell |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version | * Added default ΔCFM values for midstream delivery products |

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 be used if blower door testing is not feasible due to health or safety concerns, or if the site-specific details are unknown such as in a midstream delivery method.

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑155 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔCFM50 | Reduction in air leakage from blower door tests at 50 Pascals pressure difference | Site-specific, if unknown calculate[[50]](#footnote-52) as ΔCFM50 =0.50xSF  If SF unknown, look up in Table 2‑159 | CFM |  |
| Fn | Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, climate zone factor | 19 | N/A | [227] |
| Fh | Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, building height factor | Look up in Table 2‑156 | N/A | [227] |
| ∆kWh/CFM | Annual electric energy savings per cubic foot per minute of reduced air leakage at 50 Pa | Look up in Table 2‑157 or Table 2‑158 | kWh/CFM | [228] |
| ∆kW/CFM | Peak coincident demand electric savings per cubic foot per minute of reduced air leakage at 50 Pa | Look up in Table 2‑157 or Table 2‑158 | kW/CFM | [228] |
| ∆therms/CFM | Annual fossil fuel energy savings per cubic foot per minute of reduced air leakage at 50 Pa | Look up in Table 2‑157 or Table 2‑158 | therms/CFM | [228] |
| CF | Coincidence factor | Look up in Table 2‑160 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑160 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑156 Infiltration-Leakage Ratio, building height factor

|  |  |
| --- | --- |
| Number of conditioned stories | Fh |
| 1 story | 1.00 |
| 1.5 stories | 0.90 |
| 2 stories | 0.81 |
| 2.5 stories | 0.76 |
| 3 + stories | 0.70 |

Table 2‑157 Impact per CFM for Single-family Residential Infiltration Reduction

|  |  |  |  |
| --- | --- | --- | --- |
|  | ∆kWh/CFM | ∆kW/CFM | ∆therms/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 |
| Fuel Heat Only | 0.8 | 0.000 | 1.7 |
| Electric heat Only | 38.4 | 0.000 | N/A |

Table 2‑158 Impact per CFM for Multifamily Low-rise Infiltration Reduction

|  |  |  |  |
| --- | --- | --- | --- |
|  | ∆kWh/CFM | ∆kW/CFM | ∆therms/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 |

Table 2‑159 Default ΔCFM50 for Midstream Delivery Products

|  |  |
| --- | --- |
| Product | ΔCFM50 (cfm/lin.ft) |
| Door sweep | 0.639 |
| Door sealing material | 0.639 |
| Spray foam | 0.689 |

Peak Factors

Table 2‑160 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Coincidence factor | 0.69 | [229] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 15 years [230].

References

1. 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](http://eta-publications.lbl.gov/sites/default/files/estimation_of_inflitration_from_leakage_and_climate_indicators.pdf%20)
2. 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.
3. 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.
4. 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>

### Insulation

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Shell |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Savings from reduction in Air Conditioning Load:

Savings for homes with electric heat (Heat Pump or resistance):

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑161 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhcooling | Annual electric cooling energy savings | Calculated | kWh/yr |  |
| ΔkWhheating | Annual electric heating energy savings | Calculated | kWh/yr |  |
| Rb | R-value of existing insulation | Site-specific, if unknown look up in Table 2‑163 | h.ft2.°F/Btu |  |
| Rq | R-value of new insulation | Site-specific | h.ft2.°F/Btu |  |
| CDD | Cooling degree days: number of degrees the average daily temperature is above 65°F | Loo kup in Table 2‑164 | °F-day/yr | [231] |
| Area | Area of insulated surface | Site-specific | ft2 |  |
| Fframing | Framing factor | Look up in Table 2‑162 | N/A | [233] |
| 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 2‑165 | Btu/watt-hr | [234] |
| EER/EER2 | Efficiency in EER of Air Conditioning equipment | Site-specific. If unknown, see Appendix E: Code-Compliant Efficiencies | Btu/watt-hr | [234] |
| HDD | Heating degree days: number of degrees the average daily temperature is below 65°F | Look up in Table 2‑164 | °F-day/yr | [231] |
| HSPF/HSPF2 | Heating Seasonal Performance Factor | Site specific, if unknown look up in Table 2‑166 | Btu/watt-hr | [234] |
| Fuel Btu | Conversion Factor to Therms | Look up in Table 2‑169 |  |  |
| AFUE | Annual Fuel Utilization Efficiency – Boilers & Furnaces | Site-specific, if unknown look up in Table 2‑167, Table 2‑168 | N/A | [234] |
| AFUE | Annual Fuel Utilization Efficiency – Electric Resistance Heating | 35% | N/A | [235] |
| CF | Electric coincidence factor | Look up in Table 2‑170 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑170 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑162 Framing Factor

|  |  |  |
| --- | --- | --- |
| Insulation Location | Value | Ref |
| Framing factor - Ceiling | 7% | [233] |
| Framing factor - Wall | 25% | [233] |
| Framing factor - Floor | 12% | [233] |

Table 2‑163 Existing Insulation R-Value (Rb)

|  |  |
| --- | --- |
| Building Envelope Component | Value |
| Fiberglass - Batt | 3.14 |
| Fiberglass – Blown Attic | 2.2 |
| 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/ft3) | 4 |
| Expanded Polystyrene (Beadboard) | 4 |
| Extruded Polystyrene | 5 |
| Polyurethane (Foamed-in-place) | 6.25 |
| Polyisocynaurate (Foil-face) | 7.2 |

Table 2‑164 Heating and Cooling Degree Days (65°F set point)

|  |  |  |
| --- | --- | --- |
| Climate Zone | HDD | CDD |
| Northern | 6,136 | 934 |
| Southwest | 5,658 | 1,048 |
| Coastal | 4,795 | 886 |
| Central | 5,588 | 1,008 |
| Pine Barrens | 5,529 | 945 |
| Statewide Average | 5,553 | 973 |

Table 2‑165 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 2‑166 Cooling Equipment HSPF

|  |  |  |
| --- | --- | --- |
| Cooling Equipment | HSPF | HSPF2 |
| Split System (HP) | 8.2 | 7.5 |
| Single Package (HP) | 8.0 | 6.7 |

Table 2‑167 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 2‑168 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 2‑169 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 2‑170 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [232] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 25 years [236].

References

1. ONJSC: Monthly/Annual Temperature Normals (1991-2020). <http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html>.
2. 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
3. ASHRAE, 2001, “Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP),” Table 7.1.
4. 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>

1. 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.
2. GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures.

### Window Insulation

|  |  |
| --- | --- |
| Market | Residential |
| Baseline Condition | Retrofit |
| Baseline | Existing |
| End Use Subcategory | Window |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version |  |

Description

This measure covers the installation of plastic window insulation film covering the interior side of a window frame. The film is sealed around the frame with adhesive tape, creating an insulating air gap between the window glass and the plastic film. This gap can only be achieved if the film is maintained without any cuts or slits. The reduced thermal conduction saves energy by decreasing heating loads on the dwelling’s heating systems.

This measure claims only energy savings from heating a dwelling since it is assumed that the plastic window insulation is removed outside of the heating season to allow the windows to be opened.

Baseline Case

Existing window without insulation film.

Efficient Case

Windows with insulation film sealed with the help of adhesive tape.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑171 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated or look up in Table 2‑173 | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated or look up in Table 2‑173 | Therms/yr |  |
| ΔThermsPeak | Peak day gas savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| A | Glazing area of impacted windows[[51]](#footnote-53) in square feet | Site-specific,  if unknown use 6 square feet per window | ft2 | [237] |
| COP | Coefficient of performance of electric heating equipment (convert HSPF to COP by dividing by 3.412) | Site-specific,  if unknown look up in Appendix E for existing efficiency of heating equipment, if heating equipment unknown, assume 1.37[[52]](#footnote-54) | N/A | [237] |
| EffFuelHeat | Efficiency of fuel heating equipment | Site-specific,  if unknown look up in Appendix E for existing efficiency of heating equipment, if heating equipment unknown, assume 0.79[[53]](#footnote-55) | N/A | [237] |
| HDD | Heating degree days (basis 65°F) | Lookup in Table 2‑172 HDD65 values for various NJ Location | N/A | [238] |
| Rw | R-value of existing windows | Site-specific, if unknown use 1.13 | h.ft2. °F/Btu | [237] |
| RI | R-value added as a result of plastic window insulation[[54]](#footnote-56) | 1.74 | h.ft2. °F/Btu | [237] |
|  |  |  |  |  |
| FElecHeat | Electric heating factor | Electric heating: 1.0 Otherwise: 0.0  If unknown: look up in Appendix K | N/A | [237] |
| FFuelHeat | Fossil fuel heating factor | Fuel heating: 1.0 Otherwise: 0.0  If unknown: look up in Appendix K | N/A | [237] |
| PDF | Peak Day Factor | See Appendix | N/A |  |
| 24 | Hours in a day | 24 | Hrs |  |
| 3,412 | Unit conversion, Btu/kWh | 3,412 | Btu/kWh |  |
| 100,000 | Unit conversion, Btu/therm | 100,000 | Btu/therm |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Table 2‑172 HDD65 values for various NJ Location

|  |  |
| --- | --- |
| Location | HDD65 |
| Northern | 6,136 |
| Southwest | 5,658 |
| Coastal | 4,795 |
| Central | 5,588 |
| Pine Barrens | 5,529 |
| **Statewide Average** | **5,553** |

If the default values for all the parameters are used, the calculations result in the deemed values below.

Table 2‑173 Deemed kWh and Therms Savings Value, per Window

|  |  |  |
| --- | --- | --- |
| Location | ΔkWh | ΔTherms |
| Northern | 101.42 | 6.08 |
| Southwest | 93.52 | 5.60 |
| Coastal | 79.25 | 4.75 |
| Central | 92.36 | 5.53 |
| Pine Barrens | 91.38 | 5.48 |
| **Statewide Average** | **91.58** | **5.49** |

Peak Factors

**Table 14 Peak Factors**

|  |  |  |
| --- | --- | --- |
| **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 1 year[[55]](#footnote-57) [237].

References

1. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 11, Effective Date January 2024, <https://dps.ny.gov/technical-resource-manual-trm>
2. HDD65 calculated with TMY3 weather data for representative weather stations for each NJ climate zone. See Appendix A.

## Water Heating

### 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 |
| Changes Since Last Version |  |

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.[[56]](#footnote-58) 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

Where,

Annual Fuel Savings

Where,

Peak Demand Savings[[57]](#footnote-59)

For water heaters with a rated storage volume of 55 gallons or less:

For water heaters with a rated storage volume greater than 55 gallons:

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑174 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhdhw | Annual domestic hot water electric energy savings | Calculated | kWh/yr |  |
| ΔkWhcooling | Annual cooling electric energy savings | Calculated | kWh/yr |  |
| ΔkWhheating | Annual heating electric energy impacts | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsdhw | Annual domestic hot water fuel savings | Calculated | Therms/yr |  |
| ΔThermsheat | Annual space heating fuel impacts | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Loaddhw | Annual hot water load | Calculated | Btu |  |
| vt | Tank volume | Site-specific | Gal |  |
| UEFq | Uniform energy factor of efficient unit | Site-specific, if unknown look up in Table 2‑176 | N/A | [245] |
| AFUE | Annual fuel utilization efficiency of existing space heating or domestic hot water boiler or furnace | Site-specific, if unknown look up in Table 2‑179 | N/A | [242] |
| GPD | Gallons per day | Calculated, if Nppl unknown use 46 | Gal/day | [239] |
| Nppl | Number of people in the home | Site-specific, if unknown use default 2.65 | persons | [248] |
| FDHW,electric | Electric water heating factor | Look up in Table 2‑175 | N/A |  |
| FDHW,g | Gas water heating factor | Look up in Table 2‑175 | N/A |  |
| FDHW,boiler | Gas boiler water heating factor | Look up in Table 2‑175 | N/A |  |
| Fheat,electric | Electric space heating factor | Look up in Table 2‑175 | N/A |  |
| Fheat,g | Gas space heating factor | Look up in Table 2‑175 | N/A |  |
| UEFb | Uniform energy factor of baseline unit as a function of baseline fuel type. | Look up in Appendix E: Code-Compliant Efficiencies | N/A | [242][243] |
| Fderate | Efficiency derating factor | Look up in Table 2‑177 | N/A | [244][245] |
| Flocation | Installation location factor | Look up in Table 2‑177 | N/A |  |
| SEER | Seasonal energy efficiency ratio of existing air conditioning system | Look up in Table 2‑178 | Btu/W·hr |  |
| HSPF | Heating seasonal performance factor of existing electric heating system | Look up in Table 2‑178 | Btu/W·hr |  |
| CF | Electric coincidence factor | Look up in Table 2‑180 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑180 | N/A |  |
| Tset | Water heater setpoint temperature | 125 | °F | [240] |
| Tmain | Supply water temperature in water main | 60 | °F | [241] |
| Fcool | Cooling factor | 0.51 | N/A | [243] |
| Fheat | Heating factor | 0.49 | N/A | [243] |
| 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 2‑175 DHW and Heating Factors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Baseline Scenario | FDHW,electric | FDHW,g | FDHW,boiler | Fheat,electric | Fheat,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 2‑176 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 2‑177 Derating Factors

|  |  |  |
| --- | --- | --- |
| Area | Fderate | Flocation |
| Unconditioned Basement | 0.86 | 0 |
| Garage | 0.83 | 0 |
| Conditioned Space | 1.00 | 1.00 |
| Unknown[[58]](#footnote-60) | 0.95 | 0.62 |

Table 2‑178 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 2‑179 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 2‑180 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 2‑181 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Heat Pump Water Heater | 10 | 3.33 | [247] |

References

1. 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>
2. 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>
3. 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
4. 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>
5. 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>
6. 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>
7. 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>
8. 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>
9. 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>
10. 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

### 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

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑182 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| GPD | Gallons per day | Calculated, if Nppl unknown use 46 | Gal/day | [249] |
| ΔTmain | Average temperature difference between water heater set point temperature (Tset) and the supply water temperature in water main (Tmain) | Calculated | °F |  |
| ΔTamb | Average temperature difference between water heater set point temperature (Tset) and the surrounding ambient air temperature (Tamb) | Calculated | °F |  |
| UAq | Overall heat loss coefficient of the energy efficient equipment | Calculated, if SLq unknown use 5.4 | (Btu/h-°F). | [254] |
| Effq | Efficiency of energy efficient connected boiler (AFUE) | Site-specific. If unknown use 0.85[[59]](#footnote-61) | N/A |  |
| Nppl | Number of people in household | Site-specific, if unknown use default 2.65 | N/A | [254] |
| SLq | Standby loss specification of installed equipment. Use given UAq assumption if SLq is unknown. | Site-specific | °F/hr |  |
| vq | Rated storage capacity of installed equipment | Site-specific | Gal |  |
| UAb | Overall heat loss coefficient of the baseline condition | 7.85 | (Btu/h-°F). | [252] |
| Tset | Water heater set point temperature | 125 | °F | [250] |
| Tmain | Supply water temperature in water main | 60 | °F | [251] |
| Tamb | Surrounding ambient air temperature | 70[[60]](#footnote-62) | °F |  |
| Effb | Efficiency of the baseline condition, deemed (AFUE) | 0.75 | N/A | [252] |
| 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 |  |

Peak Factors

Table 2‑183 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 2‑184 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Indirect Water Heater | 11 | 3.67 | [255] |

References

1. 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. 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>.
3. Burch, Jay and Christensen, Craig, *Towards Development of an Algorithm for Mains Water Temperature*. National Renewable Energy Laboratory, 2022.
4. 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>.
5. 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.
6. 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>.
7. 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>

### 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. [261] Minimum UEF qualification for ENERGY STAR® equipment is shown in Table 2‑186.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑185 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| GPD | Gallons per day | Calculated, if unknown use 46 | Gal/day | [256] |
| DTmain | Average temperature difference between water heater set point temperature and the supply water temperature in water main | Calculated | °F |  |
| UEFq | Uniform Energy Factor of the energy efficient measure | Site-specific, if unknonwn look up in Table 2‑186 | N/A |  |
| Nppl | Number of people served by the system | Site-specific, if unknown use default 2.65 | persons | [256] |
| Tset | Water heater set point temperature | 125 | °F | [257] |
| Tmain | Supply water temperature in water main[[61]](#footnote-63) | 60 | °F | [258] |
| UEFb | 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 | [256] |
| CF | Electric coincidence factor | Look up in Table 2‑187 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑187 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑186 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 2‑187 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [260] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 11 years for gas water heaters and 13 years for electric water heaters. [259]

References

1. Water Research Foundation: “Residential End Uses of Water, Version 2: Executive Report”, April 2016, <https://www.mrwa.com/PDF/2016WaterEndUseReport.pdf>
2. 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>
3. 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
4. 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/
5. 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>.
6. 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>

### 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

Where,

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑188 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔTherms-dayPeak | Daily peak fuel savings | N/A | Therms/day |  |
| ΔTmain | Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F) | Calculated | °F |  |
| ΔTamb | Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F) | Calculated | °F |  |
| GPD | Gallons per day | Calculated, if Nppl unknown, use 46 | Gal/day | [262] |
| Nppl | Number of people in household | Site-specific. If unknown, use 2.65 | N/A | [269] |
| Tset | Water heater set point temperature | Site-specific. If unknown, use 125 | °F | [263] |
| Tmain | Supply water temperature in water main | 60 | °F | [264] |
| Tamb | Surrounding ambient air temperature | 70 | °F |  |
| UEFb | Uniform Energy Factor of the baseline condition | Retrofit: Site-specific  New construction: Look up in Appendix E: Code-Compliant Efficiencies | N/A | [267] |
| UEFq | Uniform Energy Factor of the energy efficient measure. | Site-specific | N/A |  |
| UAb | Overall heat loss coefficient of the baseline condition. | Storage water heater baseline: UAb = 7.85  Indirect water heater baseline: UAb = 0 | (Btu/h-°F). | [265] |
| UAq | Overall heat loss coefficient of the energy efficient measure. | 0 | (Btu/h-°F). | [266] |
| 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 2‑189 | N/A |  |
| PDF | Peak day factor | Look up in Table 2‑189 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 2‑189 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [268] |
| 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 2‑190 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | New construction EUL | Retrofit RUL | Ref |
| Instantaneous Water Heater | 20 | 6.66 | [268] |

References

1. 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. 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.
3. Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022.
4. 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.
5. Based on the average standby loss specification (in °F/hr) of AHRI-certified Indirect Water Heater storage tanks, per the AHRI Directory, December 2022.
6. 10 CFR 430.32(d), December 2022.
7. 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>
8. *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>

### Combination Boiler

|  |  |
| --- | --- |
| Market | Residential |
| Baseline Type | TOS/NC/EREP |
| Baseline | Code/Existing/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | January 2024 |
| Changes Since Last Version |  |

Description

This section provides energy savings algorithms for qualifying gas combination boilers installed in residential 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, and regional estimates of average baseline water heating energy usage.

For new construction, and time of sale replacement of failed equipment at the end of the boiler useful life, the baseline unit is a code compliant unit with an efficiency as required by IECC 2021, which is the current code adopted by the State of New Jersey.

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:

* NC/TOS: Single baseline of boiler of the same fuel type as the installed equipment which is compliant with IECC 2021.
* EREP: Dual baseline
* First baseline for existing equipment RUL: Existing boiler efficiency. If unknown, use minimally code-compliant efficiency from code in force at time of installation. If installation year is unknown, assume ⅔ EUL has elapsed.
* Second baseline for remainder of measure EUL: Boiler compliant with IECC 2021.

Domestic Hot Water Component:

* NC/TOS: Single baseline of a storage water heater of the same fuel type as the installed equipment which is compliant with IECC 2021.
* EREP: Dual baseline
* First baseline for existing equipment RUL: Existing water heater efficiency. If unknown, use minimally code-compliant efficiency for a storage water heater from code in force at time of installation. If installation year is unknown, assume ⅔ EUL has elapsed.
* Second baseline for remainder of measure EUL: Storage water heater compliant with IECC 2021.

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

Annual Fuel Savings

Where*,*

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 2‑191 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔThermsBoiler | Annual fuel savings from space heating | Calculated | Therms/day |  |
| ΔThermsDHW | Annual fuel savings from water heating | Calculated | Therms/day |  |
| GPD | Gallons per day of hot water use | Calculated, if unknown use 46 | Gal/day | [277] |
| Capin | Input capacity of qualifying boiler | Site-specific | kBtu/hr |  |
| AFUEq | Boiler proposed efficiency | Site-specific | N/A |  |
| NPeople | Number of people served by the system | Site-specific | people |  |
| Tset | Water heater setpoint temperature | Site-specific, if unknown, use 125 | °F | [84] |
| UEFq | Efficient case water heater Uniform Energy Factor | Site-specific, if unknown use 0.87[[62]](#footnote-64) | N/A |  |
| EFLHh | Boiler equivalent full load hours of operation during heating season | Look up in Appendix CAppendix C: | Hours | [83] |
| AFUEb | Boiler baseline efficiency | TOS/NC: Code compliant baseline values given in Table 2‑192  EREP: Site-specific, if unknown use code efficiency in force when equipment was new. If vintage unknown, assume ⅔ EUL has elapsed. | N/A | [271] |
| UEFb | Baseline water heater Uniform Energy Factor | TOS/NC: Code compliant baseline values if unknown use 0.657  EREP: Site-specific, if unknown use code efficiency in force when equipment was new. If vintage unknown, assume ⅔ EUL has elapsed. | N/A | [86] |
| Tmain | Incoming water main temperature[[63]](#footnote-65) | 60 | °F | [85] |
| 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/gal̇⋅F |  |
| 100,000 | Unit conversion, Btu/therm | 100,000 | Btu/therm |  |
| 8,760 | Hours in one year | 8760 | Hours |  |
| PDF | Peak day factor | Look up in Table 3‑382 | N/A |  |
| EUL | Estimated useful life | See Measure Life Section | Years | [88] |

Table 2‑192 Baseline AFUE of Single Family 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 |

Peak Factors

Table 2‑193 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | N/A |  |
| Natural gas peak day factor (PDF) | See Appendix |  |

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 2‑194 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Combination Boiler | 22 | 7.3 | [88] |

References

1. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
2. 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.
3. Burch, Jay and Christensen, Craig, *Towards Development of an Algorithm for Mains Water Temperature* (National Renewable Energy Laboratory). https://www.energystar.gov/ia/partners/prod\_development/new\_specs/downloads/water\_heaters/AlgorithmForMainsWaterTemperature.pdf
4. The referenced federal standards for the baseline UEF are dependent on both draw pattern and tank size. A weighted average baseline UEF was calculated with a medium draw pattern from the referenced federal standards and water heating equipment market data from the Energy Information Association 2009 residential energy consumption survey for NJ[[64]](#footnote-66) assuming tank sizes of 30 gallons for small water heaters, 40 gallons for medium water heaters, and 55 gallons for large water heaters.
5. “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.
6. <https://www.regulations.gov/document/EERE-2015-BT-TP-0007-0004>
7. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010
8. 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.

### Water Heating Setback

|  |  |  |
| --- | --- | --- |
| Market | Residential/Multifamily |  |
| Baseline Condition | RF |  |
| Baseline | Existing |  |
| End Use Subcategory | Control |  |
| Measure Last Reviewed | December 2022 |  |
| Changes Since Last Version |  |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑195 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔTherms-dayPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLifetime | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLifetime | Lifetime fuel savings | Calculated | Therms |  |
| U | Overall heat transfer coefficient of tank | Site-specific, if unknown use 0.083[[65]](#footnote-67) | (Btu/Hr-°F-ft2) |  |
| A | Surface area of storage tank | Site-specific, if unknown look up in Table 2‑196 | Ft2 | [278] |
| Tb | Hot water setpoint prior to adjustment | Site-specific, if unknown use 130 | °F | [281] |
| Tq | New hot water setpoint | Site-specific, if unknown, use 120 | °F | [280] |
| Hours | Number of hours in a year | 8760 | Hrs/yr |  |
| REelectric | Recovery efficiency of water heater | Electric Hot Water Heater: 0.98  Heat Pump Water Heater: 2.1 | N/A | [278] |
| REgas | Recovery efficiency of gas water heater | 0.8 | N/A | [279] |
| 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 2‑197 | N/A |  |
| EUL | Effective useful life | See Measure Life | Years |  |
| RUL | Remaining useful life of existing unit | See Measure Life | Years |  |

Table 2‑196 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 2‑197 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 [280].

References

1. 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>.
2. 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](https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431" \l "431.110).
3. Mid-Atlantic TRM V10, December 2022. <https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf>.
4. *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/

### Faucet Aerators and Showerheads

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF/TOS |
| Baseline | Existing/Code |
| End Use Subcategory | Water Conservation |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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) per unit from the baseline (existing) fixture to the efficient low-flow fixture. This measure applies to residential and multifamily buildings.

Baseline Case

TOS: the baseline is a standard faucet or a showerhead meeting maximum flow given in the NJ A5160 [73].

RF: the baseline is the actual flow rate of the existing faucet. If unknown, default to the TOS baseline of a standard faucet or a showerhead meeting maximum flow given in the NJ A5160.

Efficient Case

The efficient condition is an energy efficient faucet aerator or showerhead with rated flow rate less than maximum flow rate given in the NJ A5160 [73]. Actual flow rates of the installed fixture are used to estimate the savings.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Where,

Aerators:

Showerheads:

Aerators:

Showerhead:

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑198 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔH2O | Annual water savings | Calculated | Gal/yr |  |
| ΔTmain | Average temperature different between faucet operating temperature and the supply water temperature | Calculated. If unknown, use 25. | °F |  |
| UEF | Uniform Energy Factor[[66]](#footnote-68) | Site-specific. If unknown, assume 0.92 (electric) or 0.58 (gas) | N/A | [289] |
| Nfaucet | Faucets per household | Site-specific. If unknown, look up in Table 2‑199 | N/A | [288] |
| Nshower | Showers per household | Site-specific. If unknown, look up in Table 2‑199 | N/A | [288] |
| Npersons | Average number of people per household | Site-specific. If unknown, assume 2.66 | Person/  household | [282] |
| GPMb | Baseline flowrate | RF: Site-specific, if unknown look up in Table 2‑199  TOS: Look up in Table 2‑199 | Gal/min | [284], [287] |
| GPMq | Efficient flowrate | Site-specific | Gal/min | [287] |
| Tfaucet | Faucet existing temperature | Site-specific. If unknown, look up in Table 2‑199 | °F | [290] |
| Tshower | Showerhead existing temperature | Site specific, use 105 if unknown | °F | [292] |
| Felec | 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 KAppendix K: DHW and Space Heat Fuel Split or default[[67]](#footnote-69) = 0.25 | N/A |  |
| Fgas | 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 or default [[68]](#footnote-70) = 0.71 | N/A |  |
| tuse | Average minutes of use per person per fixture per day | Look up in Table 2‑199 | Minutes/  person/day | [283], [293] |
| Fthrottle, b | Ratio of user setting to full throttle flow rate for baseline fixture | Aerator: 0.83  Showerhead: 0.9 | N/A | [286], [293] |
| Fthrottle, q | Ratio of user setting to full throttle flow rate for low flow fixture | Aerator: 0.95  Showerhead: 0.9 | N/A | [286], [293] |
| Tmain | Supply water temperature in water main[[69]](#footnote-71) | 60 | °F | [285] |
| ETDF | Energy to Demand Factor | Aerator: 0.000134  Showerhead: 0.00008014 | kW/kWh/yr | [284] |
| 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 2‑200 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 2‑199 Calculation Assumptions per Fixture Type

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fixture Type | Location | Baseline gallons per minute (GPMb) | Daily use duration (tuse) | Operating temperature (Tfaucet, Tshower) (°F) | Faucets/household (Nfaucet) |
| Faucet aerator | Kitchen | 1.8  2.39 (ETG)  2.58 (SJG) | 4.5 | 93 | 1 |
| Private restroom | 1.5  2.33 (ETG)  2.82 (SJG) | 1.6 | 86 | 1.75 |
| Unknown | 1.6 | 2.5 | 88 | 1.5 |
| Showerhead | Any | 2.0  2.37 (ETG)  2.62 (SJG) | 6.15 | 105 | QHEC[[70]](#footnote-72): 1.56  HPwES6: 2.46 |

Peak Factors

Electric coincidence is included in the ETDF factor.

Table 2‑200 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) for both aerators and showerheads is 10 year [291].

Non-Energy Impacts

Aerators:

Showerhead:

References

1. 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>
2. Cadmus and Opinion Dynamics Evaluation Team. Showerhead and Faucet Aerator Meter Study. For Michigan Evaluation Working Group. June 2013.
3. Pennsylvania Technical Reference Manual; effective June 2016, pp. 114ff. <http://www.puc.pa.gov/pcdocs/1370278.docx>
4. 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>
5. 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.
6. Baseline flow rates established by State of New Jersey, 219th Legislature, Assembly No 5610
7. American Housing Survey Table Creator, United States Census Bureau, Housing Unit Characteristics, New York 2017 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>
8. 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.
9. *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.
10. California eTRM, CPUC Support Tables: Effective Useful Life and Remaining Useful Life <https://www.caetrm.com/cpuc/table/effusefullife>/; EUL ID: WtrHt-WH-Aertr, WtrHt-WH-Shrhd
11. 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>.
12. 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.

### Thermostatic Showerheads

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Water Conservation |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑201 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhlife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermslife | Lifetime fuel savings | Calculated | Therms |  |
| GPM | Flow rate of the showerhead | Site-specific, if unknown look up in Table 2‑202 | Gal/min | [294][301] |
| Person/Household | Average number of people per household | Site-specific, if unknown assume 3.36 (ETG)  2.46 (SJG)  2.66 (All others) | Person/  household | [296] |
| Showers/person/day | Showers Per Capita Per Day | Site-specific, if unknown assume 0.75 | Showers/person/day | [297] |
| NShower | Average number of showerheads Per Household | Site-specific, if unknown assume 1.10 | N/A | [298] |
| UEF | Uniform Energy Factor | Site-specific, if unknown assume 0.92 (electric) or 0.58 (gas) | N/A | [302] |
| FElec | Water heater fuel factor - electric | Look up in Table 2‑203 | N/A |  |
| FNG | Water heater fuel factor - gas | Look up in Table 2‑203 | N/A |  |
| FThrottle | Ratio of actual shower gpm to showerhead rated gpm | 0.9 | N/A | [297] |
| MinWaste | Hot water waste time avoided due to thermostatic restrictor valve | 0.98 | Minutes | [295] |
| TShower | Temperature at showerhead | 105 | °F | [299] |
| TMain | Supply water temperature in water main[[71]](#footnote-73) | 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) | [300] |
| CF | Electric coincidence factor | Look up in Table 2‑204 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 2‑204 | 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 2‑202 GPM

|  |  |
| --- | --- |
| Installation case | GPM |
| Existing Showerhead | 2.5 |
| New Conventional Showerhead | 2.0 |
| Low Flow Showerhead | 1.5 |

Table 2‑203 Water Heater Fuel Factors

|  |  |  |
| --- | --- | --- |
| Water Heater Fuel Type | FElec | FNG |
| 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 2‑204 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | N/A[[72]](#footnote-74) |  |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

Table 2‑205 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Thermostatic Showerheads | 10 | 3.3 | [303] |

References

1. Cadmus and Opinion Dynamics Evaluation Team. *Showerhead and Faucet Aerator Meter Study: For Michigan Evaluation Working Group.* (June, 2013).
2. Cadmus memo to PPL Electric. *PPL Electric 2014 ShowerStart Pilot Study*. (November 2014).
3. 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>.
4. 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>.
5. 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>
6. 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>.
7. 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.
8. Maximum flowrates for new showerheads taken from New Jersey P.L. 2021, c. 464 Enacted January 2022. <https://legiscan.com/NJ/bill/A5160/2020>
9. 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.
10. 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/

### Pipe Insulation

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Insulation |
| Measure Last Reviewed | November 2022 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

*Peak Demand Savings*

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 2‑206 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| L | Length of installed insulation | Site-specific | ft |  |
| Tpipe | Average temperature of hot water or steam in distribution system piping | Site-specific, if unknown: DHW: 125  HW Boiler[[73]](#footnote-75): 160  Steam Boiler[[74]](#footnote-76): 212 | °F | [308] |
| Tamb | Surrounding average ambient air temperature | Site-specific, if unknown: DHW: 70  Space Heat: 50 | °F | [311] |
| Etfuel | Recovery Efficiency of fuel water heaters or AFUE of boiler for space heating | Site-specific, if unknown:  DHW[[75]](#footnote-77): 0.75  Space Heating Boilers: Look up in Table 2‑209 | N/A | [306][313] |
| Etelec | Recovery Efficiency of electric water heaters | Site-specific, if unknown:  Non- Heat Pump DHW[[76]](#footnote-78): 0.98  Heat Pump DHW: Look up in Table 2‑210 | N/A | [307][309] |
| hrs | Annual operating hours | For DHW: 8,760  Boilers: Look up heating EFLH in Appendix C: Heating and Cooling EFLH | hrs | [314] |
| (UA/L)b | Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from uninsulated pipe[[77]](#footnote-79) | Look up in Table 2‑207 | Btu/hr-°F-ft | [310] |
| (UA/L)q | Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from insulated pipe78 | Look up in Table 2‑208 | Btu/hr-°F-ft | [315] |
| SFelec | 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[[78]](#footnote-80) = 0.18 | N/A | [312] |
| SFfuel | 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 [[79]](#footnote-81) = 0.82 | N/A | [312] |
| CF | Electric coincidence factor | Look up in Table 2‑211 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑211 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 2‑207 (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 2‑208 (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 |
| 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 2‑209 Etfuel 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 2‑210 Etelec for Domestic Hot Water Heaters

|  |  |  |
| --- | --- | --- |
| Size (Gallons) | UEF | Etelec |
| 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[[80]](#footnote-82) | - | 3.016 |

Peak Factors

Table 2‑211 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 2‑212 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Electric Water Heaters | 13 | 4.33 | [316] |
| Gas Water Heaters | 11 | 3.66 | [316] |

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### 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 [317]. 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 [318].

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 [319].

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Where,

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑213 Calculation Parameters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref | |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  | |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  | |
| ΔkWhLife | 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 | [320] | |
| Vpool | Volume of pool | Site-specific, if unknown use 22,000 gallons (inground)  7,540 (above ground) | Gallons | [321][325] | |
| Nturnover | 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 | [321] | |
| WEFb | Minimum allowable Federal Weighted Energy Factors | Look up in Table 2‑214 | kgal/kWh | [318][319] | |
| WEFq | Energy Efficient Pool Pumps Weighted Energy factor, per Energy Star certificate | Site-specific, min qualifying in Table 2‑214 | kgal/kWh | [318][319] | |
| HHP | Hydraulic horsepower, per energy star certificate | Site-specific | hp | [319] | |
| Hrsdaily | Daily hours of pump operation | Site-specific, if unknown use 5.18 | hrs | [322] | |
| CF | Coincidence factor | Look up in Table 2‑215 | N/A | [323] | |
| PDF | Peak day factor | Look up in Table 2‑215 | N/A |  | |
| EUL | Effective useful life | See Measure Life Section | Years |  | |

Table 2‑214 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 2‑215 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.27 | [323] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 10 years [324].

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## Whole Building

### 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

= Savings derived from annual evaluation compliant with Behavioral Guidance Document

Annual Fuel Savings

*s* = Savings derived from annual evaluation compliant with Behavioral Guidance Document

Peak Demand Savings

= Savings derived from annual evaluation compliant with Behavioral Guidance Document

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑216 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated per NJ Behavioral Program Guideline | kWh | [326] |
| ΔTherm | Annual natural gas savings | Calculated per NJ Behavioral Program Guideline | therms | [326] |
| ΔkWPeak | Peak Demand Savings | Calculated per NJ Behavioral Program Guideline | kW | [326] |
| ΔThermsPeak | Daily peak fuel savings | 0 | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔThermsPeak | Daily peak fuel savings | 0 | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| EUL | Effective useful life | See Measure Life Section | yr | [331] |

Table 2‑217 Annual Savings Percentage from Tri 1 PY1 Evaluations

|  |  |  |
| --- | --- | --- |
| Percent Savings [327][328][329][330] | | |
| **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 [331].

References

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### 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 [332]. 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 [333].
* Software approved by the US Department of Energy’s Weatherization Assistance Program [334].
* RESNET approved rating software [335].

There are numerous software packages that comply with these standards. Some examples of the software packages are SnuggPro[[81]](#footnote-83)[336], REM/Rate, EnergyGauge and TREAT.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Where,

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 2‑218 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated by Approved Software | kWh/yr |  |
|  | Annual fuel savings | Calculated by Approved Software | Therm/yr |  |
|  | Peak demand savings | Calculated | kW |  |
|  | Daily peak fuel savings | Calculated | Therms/day |  |
| ETDF | Energy to demand factor | 0.000364 | kW/kWh |  |
| PDF | Natural gas peak day factor | See Appendix G: Natural Gas Peak Day Factors | Day/yr |  |

References

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3. A listing of software approved by US DOE available at <https://www.energy.gov/scep/wap/weatherization-energy-audits>
4. A listing of the approved RESNET software available at <https://www.resnet.us/providers/accredited-providers/hers-software-tools/>
5. SnuggPro software <https://snuggpro.com/>
6. SJG PY2 Impact Evaluation

### New Construction

|  |  |
| --- | --- |
| Market | Residential/Multifamily |
| Baseline Condition | NC |
| Baseline | Building Code |
| End Use Category | Whole Building |
| Measure Last Reviewed | August 2024 |
|  |  |

Description

This measure addresses high performance residential and multifamily new building design and construction. High performance new construction projects must satisfy the requirements prescribed by the ENERGY STAR certification effective at the time the project permit is pulled, following either the Single-Family New Homes program [338] or the Multifamily New Construction program [339], US DOE Zero Energy Ready Home program [340], Passive House Institute US (PHIUS) [341] or Passive House Institute (PHI) [342].

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:

Where:

CF = cooling coincidence factor from Section 2.3.1

EFLHcool= cooling equivalent full load hours from Section 2.3.1

Minimum energy performance requirements for all new construction projects are measured from baselines reflecting effective, applicable energy codes and standards (e.g., IECC and ASHRAE 90.1) at the time the project permit is 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.

For projects pursuing passive house certifications, savings shall be estimated based on a comparison of baseline and proposed/as-built OR minimally passive house compliant prototype models developed in approved program simulation software. Baseline models shall reflect input parameters relevant to climate zones 4A/5A and minimally compliant with effective, applicable energy codes and standards based on project permit date. Submitted proposed/as-built design models are compared against the corresponding baseline model to establish energy consumption savings by fuel type. For electric peak demand savings, where end use-level kWh savings are reported by simulation software, peak kW shall be established per end use and aggregated for project-level reporting. In the absence of end use-level savings, peak kW savings may be approximated per the equation shown above.

To support and provide transparency to ongoing processing of project applications under the Residential New Construction (“RNC”) Program, and for applications under the New Construction Program (“NCP”), details of the approach for estimating energy savings relative to a baseline reference home are presented below.

Whole building energy savings are calculated using outputs from RESNET accredited Home Energy Rating System (HERS) modeling software [343]. All program homes are modeled using accredited software to estimate annual energy consumption for heating, cooling, hot water, and other end uses within the HERS asset rating.

The program home is then modeled to a baseline specification using a program-specific reference home (referred to in some software as a User Defined Reference Home or UDRH) feature. The program reference home specifications are set according to the lowest efficiency specified by applicable codes and standards, thereby representing a New Jersey specific baseline home against which the improved efficiency of program homes is measured.

The UDRH is designed to reflect the efficiency values of HERS Minimum Rated Features based on the following:

* The prescriptive minimum values of the IECC version applicable to the home for which savings are being calculated;
* The Federal Minimum Efficiency Standards applicable to each rated feature at the time of permitting (e.g., minimum AFUE and SEER ratings for heating and air conditioning equipment, etc.);
* An assessment of baseline practice, as available, in the event that either of the above standards reference a non-specific value (e.g., “visual inspection”);
* Exclusion of specific rated features from the savings calculation in order to remove penalties for building science based best practice requirements of the program (e.g., by setting the reference and rated home to the same value for program-required mechanical ventilation); and
* Other approved adjustments as may be deemed necessary.

The difference in modeled annual energy consumption between the program and applicable baseline reference home is the projected savings for heating, hot water, cooling, lighting, appliances, and other end uses in the HERS Minimum Rated Features, as well as on-site renewable gereration, when applicable. Coincident peak demand savings are also derived from rated modeled outputs. The following table describes the baseline characteristics of Climate Zone 4 and 5 reference homes for single-family, multi-single and low-rise multifamily buildings per IECC 2021, or as otherwise specified in the “Source” column.

Table 2‑219 User Defined Reference Home Definition\*

| **Input Parameter** | **Climate Zone 4** | **Climate Zone 5** | **Source** | **Ref** |
| --- | --- | --- | --- | --- |
| Ceiling Insulation | U= 0.024 | U=0.024 | IECC 2021, R402.1.2 (see NOTE 1 below) | [344] |
| Radiant Barrier | None | None |  |  |
| Rim/Band Joist | U=0.045 | U=0.045 | IECC 2021, R402.1.2 (see NOTE 1 below) | [344] |
| Exterior Walls - Wood | U=0.045 | U=0.045 | IECC 2021 R402.1.2 (see NOTE 1 below) | [344] |
| Exterior Walls - Steel | U=0.045 | U=0.045 | IECC 2021 R402.1.2 (see NOTE 1 below) | [344] |
| Foundation Walls | U=0.059 | U=0.050 | IECC 2021 R402.1.2 (see NOTE 1 below) | [344] |
| Doors | U=0.30 | U=0.30 | IECC 2021 R402.1.2 (see NOTE 1 below) | [344] |
| Windows | U=0.30 , SHGC=0.30 | U=0.30 , SHGC=0.30 | U-value IECC 2021 R402.1.2, SHGC changed to 0.3 to match the change the EPA made on their V3.2 and v1.2 reference home (see NOTE 1 below). | [344], [345], [346] |
| Glass Doors | U=0.30 , SHGC=0.30 | U=0.30 , SHGC=0.30 | U-value IECC 2021 R402.1.2, SHGC changed to 0.3 to match the change the EPA made on their V3.2 and v1.2 reference home (see NOTE 1 below). | [344], [345], [346] |
| Skylights | U=0.55 , SHGC=0.40 | U=0.55 , SHGC=0.40 | IECC 2021 R402.1.2 (see NOTE 1 below) | [344] |
| Floor | U=0.047 | U=0.033 | IECC 2021 R402.1.2 (see NOTE 2 below) | [344] |
| Unheated Slab on Grade | R-10, 4 ft | R-10, 4 ft | IECC 2021 R402.1.3 | [344] |
| Heated Slab on Grade | R-15, 4 ft | R-15, 4 ft | IECC 2021 R402.1.3 | [344] |
| Air Infiltration Rate | 5 ACH50 | 5 ACH50 | Based on NJ Energy code Compliance Study, June 2022, completed by DNV, ref Table 4-13 | [347] |
| Duct Leakage | 4 cfm25 per 100ft2 CFA | 4 cfm25 per 100ft2 CFA | IECC 2021, R403.3.6 | [344] |
| Mechanical Ventilation | Match to Proposed | Match to Proposed |  |  |
| Lighting | 100% High Efficacy | 100% High Efficacy | IECC 2021, R404.1 | [344] |
| Ceiling Fan (CFM/W) | 70.53 | 70.53 | eCFR: 10 CFR Part 430 Subpart C, 50” Diameter default | [348] |
| Clothes Dryer - CEF | 3.3 | 3.3 | eCFR: 10 CFR Part 430 Subpart C , for clothes dryers manufactured on or after 1/1/15, vented gas | [348] |
| Clothes Washer - IMEF | 1.57 | 1.57 | eCFR: 10 CFR Part 430 Subpart C, minimum IMEF for standard capacity top loading clothes washers manufactured on or after 1/1/2018 | [348] |
| Clothes Washer - kWh/yr | 284 | 284 | Appliance Standard 2018+Defaults | [338] |
| Dishwasher - kWh/yr | 307 | 307 | ANSI/RESNET/ICC 301-2022,  Page 64, Table 4.2.2.6.2.9 NAECA | [349] |
| Refrigerator - kWh/yr | 411 | 411 | eCFR: 10 CFR Part 430 Subpart C, top freezer, no ice maker (scenario 3) Default Size: 22 cf | [348] |
| Cooling Setpoint | 75 | 75 | IECC 2021, R403.1.1: 75 cooling and 70 heating | [344] |
| Heating Setpoint | 70 | 70 |  |  |
| Thermostat | Programmable | Programmable | IECC 2021 R403.1.1 | [344] |
| Furnace | 80% AFUE | 80% AFUE | eCFR: 10 CFR Part 340 Subpart C | [348] |
| Boiler | 84% AFUE | 84% AFUE | eCFR: 10 CFR Part 340 Subpart C | [348] |
| Combo Water Heater | N/A - default heating to Boiler and HW to Natural Gas Standalone | N/A - default heating to Boiler and HW to Natural Gas Standalone |  |  |
| Air Source Heat Pump (Heating) | N/A - default to Furnace | N/A - default to Furnace |  |  |
| Central Air Conditioning & Window AC units | 14.1 SEER/13.4 SEER2 | 14.1 SEER/13.4 SEER2 | eCFR: 10 CFR Part 340 Subpart C 14.1 SEER is the conversion from 13.4 SEER2 back to SEER, using the factor of 0.95 | [348] |
| Air Source Heat Pump (Cooling) | N/A - default to CAC/Window AC | N/A - default to CAC/Window AC |  |  |
| Electric Standalone Tank Water Heater | N/A - default to Natural Gas Standalone | N/A - default to Natural Gas Standalone |  |  |
| Natural Gas Standalone Tank Water Heater | 0.6270 UEF | 0.6270 UEF | eCFR: 10 CFR Part 340 Subpart C; assumes High Draw Pattern and a 50 gallon tank (see NOTE 3 below). | [348] |
| Electric Instantaneous Water Heater | N/A - default to Natural Gas Standalone | N/A - default to Natural Gas Standalone |  |  |
| Natural Gas Instantaneous Water Heater | N/A - default to Natural Gas Standalone | N/A - default to Natural Gas Standalone |  |  |
| Water Heater Tank Insulation | None | None |  |  |
| Duct Insulation, Attic | R-8 | R-8 | IECC 2021 R403.3.3 | [344] |
| Duct Insulation, All Other | R-8 | R-8 | IECC 2021 R403.3.2; assumes ducts >=3" | [344] |

\* - Applicable to buildings permitted on or after March 6, 2023

1 – U-values represent total system U-value, including all components (i.e., clear wall, windows, doors).

* Type A-1 - Detached one and two family dwellings.
* Type A-2 - All other residential buildings, three stories in height or less.

2 – All frame floors shall meet this requirement. There is no requirement for floors over basements and/or unvented crawl spaces when the basement and/or unvented crawl space walls are insulated.

3 – Based on the Federal Government standard for calculating UEF (50 gallon, high-draw pattern assumed): UEF = 0.6920 - (0.0013 x Rated Storage Volume in gallons)

References

1. [Energy Star V3.1 Single Family New Homes requirements](https://www.energystar.gov/partner_resources/residential_new/homes_prog_reqs/national_page)
2. [Energy Star V1.1 Multifamily New Construction requirements](https://www.energystar.gov/partner_resources/residential_new/homes_prog_reqs/multifamily_national_page)

1. [DOE Zero Energy Ready Home (ZERH) Program requirements](https://www.energy.gov/eere/buildings/doe-zero-energy-ready-home-zerh-program-requirements).
2. [Passive House Institute US requirements](https://www.phius.org/)

1. [Passive House Institute requirements](https://passivehouse.com/)
2. [Accredited Home Energy Rating Systems (HERS) software](http://www.resnet.us/professional/programs/software)
3. [2021 International Energy Conservation Code (IECC 2021)](https://codes.iccsafe.org/content/IECC2021P1)
4. [Energy Star V3.2 Single Family New Homes requirements](https://www.energystar.gov/sites/default/files/asset/document/National%20Program%20Requirements%20Version%203.2_Rev%2012.pdf)
5. [Energy Star V1.2 Multifamily New Construction requirements](https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20MFNC%20National%20Program%20Requirements%20Version%201.2_Rev04.pdf)
6. [New Jersey Energy Code Compliance Study](https://www.njcleanenergy.com/files/file/Library/FY23/Rutgers%20New%20Jersey%20Energy%20Code%20Compliance%20Report_Final_clean.pdf)
7. [Code of Federal Regulations: 10 CFR Part 430 Subpart C](https://www.ecfr.gov/current/title-10/part-430/subpart-C)
8. [ANSI/RESNET/ICC 301-2022 Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index](https://www.resnet.us/wp-content/uploads/ANSIRESNETICC301-2022_resnetpblshd.pdf)
9. Ekotrope Appliance Default Values

### 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:[[82]](#footnote-84)

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 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

1. 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
2. International Measurement and Verification Protocol (IPMVP) available at  [https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp](https://cadmusgroup.com/wp-content/uploads/2016/02/NEEP-CRL_Report_FINAL_clean.pdf?submissionGuid=cb214243-bab8-479a-a4c4-c8e5c64ae7b2)
3. ASHRAE Guideline 14-2014. Available at <https://webstore.ansi.org/standards/ashrae/ashraeguideline142014>
4. Linux Foundation, OpenEEMeter <https://lfenergy.org/projects/openeemeter/> Accessed 5/18/23.

# Commercial & Industrial

## Agriculture

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑1 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Ncows | Number of cows milked per day | Site specific | Cows |  |
| ΔESC | Annual energy savings per cow | 34[[83]](#footnote-85) | kWh/cow | [356][357][358][359] |
| ETDF | Energy to demand factor | 0.00017 | kW/kWh | [360] |
| 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 |  |

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 [355].

References

1. Idaho Power Demand Side Management Report, Supplement 1. March 15, 2022. https://docs.idahopower.com/pdfs/EnergyEfficiency/Reports/2021%20Supplement%201.pdf
2. 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.
3. Average dairy vacuum pump size was estimated based on the Minnesota Dairy Project literature.
4. Mark Mayer, David Kammel, *Dairy Modernization Works for Family Farms* (2008). <https://archives.joe.org/joe/2010october/pdf/JOE_v48_5rb7.pdf>.
5. 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/>
6. 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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑3 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 | [361] |
| Eff | Rated pump motor efficiency | Site-specific, if unknown look up in Table 3‑4 | N/A | [362][363] |
| hrs | Annual hours of pump operation | Site-specific, if unknown use 4,380 | hours | [364] |
| 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 | [367] |
| 2 | Air flow rate of milking unit | 2 | CFM | [367] |
| 1.7729 | Regression constant for the average speed of a VSD and processed milk units | 1.7729 | N/A | [367] |
| 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 | [365] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

Table 3‑6 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Dairy Pump VFD | 15 | 5 | [366] |

References

1. 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>

1. 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>
2. 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>
3. 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.
4. 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/>

1. 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. 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.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑7 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Ncows | Number of cows | Site-specific | N/A |  |
| lbsmilk | Average pounds of milk produced per cow per year | Site-specific, if unknown use 19,800 | Lbs/yr | [368] |
| Cp,milk | Specific heating capacity of milk | 0.93 | Btu/lb-°F | [369] |
| ΔT | Difference in temperature between milk entering the bulk tank and final stored temperature of cooled milk | Look up in Table 3‑8 | °F | [370][371] |
| SF | Energy savings factor | 0.05 | N/A | [372] |
| AEER | Annual energy efficiency ratio of refrigeration compressor | 15.39 | Btu/watt-hr | [371] |
| 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 [371].

References

1. 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>
2. 2018 ASHRAE Handbook – Refrigeration, Specific heat of whole milk, Table 3: Unfrozen Composition Data, Initial Freezing Point, and Specific Heat of Foods.
3. 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>
4. Sanford, Scott (University of Wisconsin–Madison). “Well Water Precoolers.” Publication A3784-3. October 2003. http://learningstore.uwex.edu/Assets/pdfs/A3784-03.pdf
5. *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>

### 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

Where,

If EERb is unknown use

Annual Fuel Savings

*N/A*

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑10 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Btu/hq | Nameplate Btu/h of installed scroll compressor | Site-specific | Btu/h |  |
| Btu/htotal | Total cooling capacity of compressors on dairy farm | Site-specific | Btu/h |  |
| Btu/hb | Nameplate Btu/h of existing recip compressor | Site-specific | Btu/h |  |
| lbsmilk | Average pounds of milk produced per cow per year | 19,800 | lb | [373] |
| 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) | [374] |
| Wb | Nameplate wattage of existing reciprocating compressor | Site-specific | watts |  |
| Wq | Nameplate wattage of installed scroll compressor | Site-specific | watts |  |
| EERq | Energy efficiency ratio of scroll compressor based on nameplate Btu/h and wattage | Calculated |  | [375] |
| EERb | Energy efficiency ratio of reciprocating compressor based on nameplate Btu/h and wattage | Calculated |  | [375] |
| 0.93 | Specific heat of milk | 0.93 | Btu/lb-°F | [376] |
| 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

1. 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>
2. 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>

1. *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>

1. 2018 ASHRAE Handbook – Refrigeration, Specific heat of whole milk, Table 3: Unfrozen Composition Data, Initial Freezing Point, and Specific Heat of Foods.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑13 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Wb | Rated wattage of baseline livestock waterer heating element | Site-specific. If unknown:  Existing: 1,100W  ISP: 500W | Watts | [377] |
| Wq | 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 | [378] |
| Fruntime | Fraction of heater runtime | 0.8 | N/A | [379] |
| 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 | [381] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 10 years [380]. 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

1. *New York Standard for Estimating Energy Savings from Energy Efficiency Programs Version 10*. (New York State Joint Utilities, 2021), pg 385.
2. Based on TMY3 data for various climate zones in New Jersey.
3. 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/>
4. 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>
5. No demand savings are expected for this measure, as the energy savings occur during the winter months.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑16 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Nacres | Number of acres irrigated | Site-specific | Acres |  |
| PSIb | Baseline pump pressure, must be measured and recorded prior to installing low-pressure irrigation equipment | Site-specific | Pounds per square inch (psi) |  |
| PSIq | 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 |  |
| Effmotor | Pump motor efficiency | Site-specific, if unknown look up in Table 3‑17 | N/A | [382] |
| 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 |  |  |
| EDTF | Energy to Demand Factor | 0.0026 | kW/kWh | [384] [385] |
| 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 [383].

References

1. *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>
2. 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.
3. 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.
4. Irrigation Water Withdrawals, 2015 by the U.S. Geological Society. Table 7. <https://pubs.usgs.gov/circ/1441/circ1441.pdf>. Accessed January 2023.

### 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.[[84]](#footnote-86)

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:

Internal circulation fans and HVLS fans:

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑19 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| CFMb | Cubic feet per minute of existing fan | Site-specific[[85]](#footnote-87), if unknown use CFMq | Ft3/min | [389] |
| CFMq | Cubic feet per minute of installed fan | Site specific | Ft3/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 |  |
| lbfb | Thrust of existing fan | Site specific[[86]](#footnote-88), if unknown use lbfq | Lbs/force | [389] |
| lbfq | Thrust of installed fan | Site-specific | Lbs/force |  |
| FVFD,q | Reduced consumption resultant from VFD control | Look up in Table 3‑21 | N/A | [387] |
| 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 [[87]](#footnote-89) | | Efficient[[88]](#footnote-90) | |
| **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 |

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[[89]](#footnote-91) | Exhaust/Ventilation Fan Hours[[90]](#footnote-92) |
| 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 | [388] |
| 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 | [386] |

References

1. 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. 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
3. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multifamily, and Commercial/Industrial Measures. January 1, 2023.
4. 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/>

### 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 ΔBTUmilk 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 ΔBTUhru, equation. The smaller of the two shall be selected. If ΔBTUmilk is smaller than ΔBTUhru, 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 ΔBTUhru is smaller than ΔBTUmilk 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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔBTUmilk | Recoverable energy from milk cooling process | Calculated | Btu |  |
| ΔBTUhru | Required energy to heat water in the storage tank unit to set temperature | Calculated | Btu |  |
| ΔTwater | Change in water temperature attributable to heat recovery system | Calculated | °F |  |
| Lbsmilk | Average pounds of milk produced per cow per year | 19,800 | Lbs/yr | [390] |
| Cows | Average number of cows milked per day | Site-specific | cow/day |  |
| ΔTmilk | Difference in temperature between milk entering the bulk tank and final stored temperature of cooled milk | Look up in Table 3‑26 | °F | [392] |
| ESF | Energy Savings Factor | 0.4 | N/A | [393] |
| Vhru | 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 | [394] |
| Tset | Expected temperature an RHR unit can pre-heat well water up to | Site-specific, if unknown look up in Table 3‑27 | °F | [393] |
| Tmain | Water main inlet temperature | Look up in Table 3‑28 | °F | [395] |
| Et,elec | Thermal efficiency of electric water heater | Site-specific, if unknown use 0.98 | N/A | [397] |
| Et,fuel | Thermal efficiency of fossil fuel water heater | Site-specific, if unknown use 0.8 | N/A | [398] |
| Hrs | Hours per year | Site-specific, if unknown use 2,920 | Hrs/yr | [396] |
| 0.93 | Specific heat of milk | 0.93 | BTU/lb °F | [399] |
| 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 (ΔTmilk °F)

|  |  |  |
| --- | --- | --- |
| No Pre-Cooler | Standard Pre-Cooler | Variable Speed Pre-Cooler |
| 60 °F | 30 °F | 18.3 °F |

Table 3‑27 RHR Setpoint Temperature (Tset)

|  |  |
| --- | --- |
| Fully condensing RHR system | Desuperheater RHR condenser |
| 130 °F | 105 °F |

Table 3‑28 Cold Water Inlet Temperature (Tmain)

|  |  |  |
| --- | --- | --- |
| NJ Climate Region | Annual Average Outdoor Temperature (°F) | Tmain (°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. [390]

References

1. 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. New Jersey Dept of Agriculture, *2021 Annual Report and Agricultural Statistics.* (2021), page 21. [2021AnnualReportFinal.pdf (usda.gov)](https://www.nass.usda.gov/Statistics_by_State/New_Jersey/Publications/Annual_Statistical_Bulletin/2021/2021AnnualReportFinal.pdf)
3. 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.
4. 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.
5. “Water Use on Dairy Farms.” 2011. MSU Extension. 2011 <https://www.canr.msu.edu/news/water_use_on_dairy_farms>. ‌
6. 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.
7. “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>.
8. 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)](https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B" \l "p-Appendix-E-to-Subpart-B-of-Part-430(6.)(6.3)(6.3.2)).
9. 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/>
10. 2018 ASHRAE Handbook – Refrigeration, Specific heat of whole milk, Table 3: Unfrozen Composition Data, Initial Freezing Point, and Specific Heat of Foods.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑30 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Wheater | Wattage of engine block heater | Site-specific, if unknown use 1,000 | W | [402] |
| hrsb | Baseline hours of use per day | Site-specific, if unknown use 10 | Hrs/day | [402] |
| hrsq | Energy efficient hours of use per day | Site-specific, if unknown use 2 | Hrs/day | [402] |
| Days | Days of use per year | Site-specific, if unknown use 90 | Days/yr | [402] |
| UF | Usage Factor | Site-specific, if unknown use 0.97 | N/A | [400] |
| 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 [401].

References

1. 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>
2. 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>
3. 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

### Electric Leaf Blower

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

Description

This measure claims savings for the replacement of an existing commercial gasoline leaf blower with an all-electric leaf blower.

Baseline Case

The baseline condition is assumed to be a commercial gasoline powered leaf blower.

Efficient Case

The efficient condition is a commercial all-electric leaf blower.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

When calculated with the default values in Table 3‑32, ΔkWh = -163.5 kWh/yr

Annual Fuel Savings (Another Fuel)

When calculated with the default values in Table 3‑32, ΔGalGasoline = 121.3 Gal/yr

Annual Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings (Another Fuel)

Calculation Parameters

Table 3‑32 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated or use default -163.5 | kWh/yr |  |
| ΔkWPeak | Annual peak demand savings | Calculated | kW/yr |  |
| ΔGalGasoline | Annual fuel savings (gasoline) | Calculated or use default 121.3 | Gal/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔGalGasoline, Life | Lifetime fuel savings (gasoline) | Calculated | Gal |  |
| kWblower | Electric demand of a commercial electric leaf blower[[91]](#footnote-93) | 0.58 | kW | [406] |
| Hrs | Annual hours of use | 282 | Hrs | [405] |
| U | Average gallons of gasoline that a baseline leaf blower consumes in one hour[[92]](#footnote-94) | 0.43 | Gal/hr | [406] |
| CF | Electric demand coincidence factor | Look up in Table 3‑33 | N/A |  |
| EUL | Effective useful life | See  Measure Life section | Years | [403] |

Peak Factors

Table 3‑33 Peak Factors

|  |  |  |
| --- | --- | --- |
| **Peak Factor** | **Value** | **Ref** |
| Electric coincidence factor (CF) | 0.5 | [407] |

Measure Life

The effective useful life (EUL) is 5 years [221].

References

1. Department of Public Services, *2022 Tier III TRM Characterizations*. 2022, Page 59, <https://publicservice.vermont.gov/document/2022-tier-iii-trm-characterizations>. Assumed measure life is sourced from a review of available warranties on electric leaf blowers in the market. It was found that there are many models available currently with a manufacturer 5 year warranty.
2. [Assuming](https://dnvnam.sharepoint.com/teams/NJBPUEMVPortfolio2/Shared%20Documents/Projects/RCGB%20sub/TRM%20Ph%202/Measure%20Finalization/Revised%20TRM%20Committee%20Redlines/Alex/Assuming) the battery will be charged on a 120v outlet, 4.8a x 120v = -0.58 kW. Charger amperage assumption from STIHL manufacturer: https://www.stihlusa.com/WebContent/CMSFileLibrary/InstructionManuals/STIHL-AR-2000-L-3000-L-Owners-Instruction-Manual.pdf
3. Quiet Communities and US Environmental Protection Agency*, National Emissions from Lawn and Garden Equipment,* 2015, Page 6, Table 3, <https://www.epa.gov/sites/default/files/2015-09/documents/banks.pdf>
4. Quiet Clean PDX, *Gas Powered Leaf Blower Noise and Emissions Factsheet*, 2019
5. Placeholder assumption until further research conducted.

### Electric Riding Lawn Mower

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

Description

This measure claims savings for the replacement of an existing gasoline powered ride-on lawnmower with a new all-electric ride-on lawnmower. This measure is characterized for commercial applications.

Baseline Case

The baseline condition is assumed to be a gasoline powered ride-on lawnmower.

Efficient Case

The efficient condition is an all-electric ride-on lawnmower.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings (Another Fuel)

Annual Peak Demand Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings (Another Fuel)

Calculation Parameters

Table 3‑34 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings, deemed value calculated using default variables below | Calculated  (Default –3,150) | kWh/yr | [221] |
| ΔkW | Annual peak demand savings | Calculated  (Default -0.56) | kW |  |
| ΔGalgasoline | Annual gasoline savings, deemed value calculated using default variables below | Calculated  (Default 900) | gal | [221] |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔGalgasoline,life | Lifetime gasoline savings | Calculated | gal |  |
| Q | Number of full charges in a year[[93]](#footnote-95) | 700 | N/A | [221] |
| Qtime | Time required to fully charge battery[[94]](#footnote-96) | 4 | Hrs | [221] |
| kWdraw | Demand draw of battery while charging | 0.56 | kW | [221] |
| Nbattery | No batteries attached to lawn mower | 2 | N/A | [221] |
| U | Annual gasoline consumption | 900 | gallons | [221] |
| CF | Electric coincidence factor | Look up in Table 3‑35 | N/A |  |
| EUL | Effective useful life | See  Measure Life section | Years | [221] |

Peak Factors

Table 3‑35 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.5 | [409] |

Measure Life

The effective useful life (EUL) is 6 years [221].

References

1. Department of Public Services, *2022 Tier III TRM Characterizations*. 2022, Page 56, <https://publicservice.vermont.gov/document/2022-tier-iii-trm-characterizations>. Commercial Riding measure life was collected by industry data from Steve W. of Eco Equipment Supply (EES).
2. Placeholder assumption until further research conducted.

### Hedge Trimmers, Push Lawnmowers, and Chainsaws

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version |  |

Description

This measure applies to the purchase of new commercial lawn equipment, which includes hedge trimmers, push lawnmowers (not self-propelled or riding, but has an electric motor driving a blade), and chainsaws to replace gas lawn equipment.

Baseline Case

The baseline equipment gasoline-powered commercial hedge trimmers, push lawnmowers, and chainsaws.

Efficient Case

The energy efficient equipment is all-electric commercial hedge trimmers, push lawnmowers, and chainsaws.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Deemed annual energy savings in Table 2‑150 calculated as follows:

Annual Fuel Savings (Alternate Fuel)

Annual Peak Demand Saving

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑36 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Look up in Table 2‑150 | kWh/yr | [221] |
| ΔGalgasoline | Annual gallons gasoline savings | Look up in Table 2‑150 | Gallons | [221] |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔGalLife | Lifetime fuel savings | Calculated | Gallons |  |
| ΔkWPeak | Annual peak demand savings | Calculated | kW |  |
| Hrs | Annual operating hours | Look up in Table 2‑149 | Hrs |  |
| tcharge | Run time per charge | Look up in Table 2‑149 | Hrs | [411] |
| Ebattery | Rated energy of the battery | Look up in Table 2‑149 | Wh | [221] |
| D | Discharge rate | 0.90 | % | [411] |
| Effcharger | Efficiency of the charger | 0.92 | % | [411] |
| 1,000 | Unit conversion, Wh/kWh | 1,000 | Wh/kWh |  |
| CF | Electric demand coincidence factor | Look up in Table 3‑39 | N/A | [412] |
| EUL | Effective useful life | See  Measure Life | Years | [221] |

The table below presents the parameters used to calculate the deemed energy impacts.

Table 3‑37 Parameters Values

|  |  |  |  |
| --- | --- | --- | --- |
| Type of Electric Equipment | Hrs | tcharge | Ebattery |
| Trimmer | 125 | 0.5 | 1HP Replacement: 100  2HP Replacement: 240 |
| Push Lawnmower | 810 | 1 | 300 |
| Chainsaw | 80 | 0.09 | 150 |

When calculated using the assumptions above, the energy impacts are equal to the values below. These deemed impacts may be used instead of calculating site-specific savings if reliable input parameters are not available.

**Table 3‑38 Deemed Energy Impacts**

|  |  |  |
| --- | --- | --- |
| Type of Electric Equipment | ΔkWh | ΔGalgasoline |
| Trimmer | 1HP Replacement: -24.5  2HP Replacement: -58.7 | 1HP Replacement: 21.5  2HP Replacement: 115 |
| Push Lawnmower | -238 | 134 |
| Chainsaw | -130 | 115 |

Peak Factors

Table 3‑39 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.5 | [412] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is given in Table 2‑152 [221].

Table 3‑40 Measure Life

|  |  |
| --- | --- |
| Type of Electric Equipment | Measure Life (yrs) |
| Trimmer | 2 |
| Push Lawnmower | 6 |
| Chainsaw | 2 |

References

1. PSEG CEF-EE II Filing 12.1.23
2. PSEG-LI TRM
3. Placeholder assumption until further research conducted.

## Appliances

### 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

*Where,*

Annual Fuel Savings

*Where,*

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑41 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhwasher | Annual electric energy savings attributed to clothes washer operation | Calculated | kWh/yr |  |
| ΔkWhDHW | Annual electric energy savings attributed to water heating | Calculated | kWh/yr |  |
| ΔkWhdryer | Annual electric energy savings attributed to dryer operation | Calculated | kWh/yr |  |
| ΔkWhunit | Annual electric energy savings of a unit exclusive of dryer operation | Calculated | kWh/yr |  |
| ΔkWhtotal | Annual electric energy savings of a unit inclusive of dryer operation | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsDHW | Annual fuel savings attributed to water heating | Calculated | Therms/yr |  |
| ΔThermsdryer | Annual fuel savings attributed to dryer operation | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔH2O | Annual water savings | Calculated | Gal/yr |  |
| Cap | Clothes washer capacity | Site-specific. If unknown, use 3.43 | ft3 | [416] |
| Ncycles | Number of cycles per year | Site-specific. If unknown, look up in Table 3‑44 | cycles | [413] |
| kWhunit,b | Baseline rated unit electricity consumption | Site-specific. If unknown, use 241 | kWh/yr | [413] |
| kWhunit,q | Efficient rated unit electricity consumption | Site-specific. If unknown, use 97 | kWh/yr | [413] |
| Fwasher | Fraction of energy consumption attributed to clothes washer operation | Site-specific. If unknown, assume 0.20 | N/A | [413] |
| FDHW | Fraction of energy consumption attributed to water heating | Site-specific. If unknown, assume 0.80 | N/A | [413] |
| Floads | Fraction of washer loads dried in machine | Site-specific. If unknown, use 1.0 | N/A |  |
| EffDHW | Fuel water heater efficiency | Site-specific. If unknown, use 0.75 | N/A |  |
| WFq | Water factor for efficient unit | Site-specific. If unknown, look up in Table 3‑45 | Gal/(cycle∙ft3) | [416][417] |
| MEFb | Modified Energy Factor of baseline unit | Look up in Table 3‑42 | N/A | [416][417] |
| MEFq | Modified Energy Factor of efficient unit | Look up in Table 3‑42 | N/A | [416][417] |
| SFDHW,electric | Electric DHW savings factor | Look up in Table 3‑43 | N/A |  |
| SFdryer,electric | Electric dryer savings factor | Look up in Table 3‑43 | N/A |  |
| SFDHW,ff | Fossil fuel DHW savings factor | Look up in Table 3‑43 | N/A |  |
| SFdryer,ff | Fossil fuel dryer savings factor | Look up in Table 3‑43 | N/A |  |
| WFb | Water factor for baseline unit | Look up in Table 3‑45 | Gal/(cycle∙ft3) | [416][417] |
| CF | Electric coincidence factor | Look up in Table 3‑46 | N/A | [413] |
| PDF | Gas peak day factor | Look up in Table 3‑46 | N/A |  |
| Hrs | Annual operating hours | 265 | Hrs/yr | [413] |
| Ncycles, ref | Reference number of cycles per year | 392 | cycles | [413] |
| Fdryer | Dryer usage factor | 0.84 | N/A | [413] |
| Fdryer,mod | Dryer usage factor in buildings with dryer and washer | 0.95 | N/A | [413] |
| Fdryer,corr | Fossil fuel dryer correction factor | 1.12 | N/A | [413] |
| 0.03412 | Unit conversion, therm/kWh | 0.03412 | Therm/kWh |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑42 Modified Energy Factor of Baseline and Efficienct Unit

|  |  |  |
| --- | --- | --- |
| Efficiency Level | Front Loading | Top Loading |
| Federal Standard | Before January 1, 2018 | |
| 2.00 | 1.60 |
| On or After January 1, 2018 | |
| 2.00 | 1.35 |
| ENERGY STAR | 2.20 | |

Table 3‑43 DHW and Dryer Savings Factors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fuel | SFDHW,electric | SFdryer,electric | SFDHW,ff | SFdryer,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 | [418] |

Table 3‑44 Annual Cycles

|  |  |
| --- | --- |
| Type | Number of Cycles |
| Multifamily Common Area | 1,241 |
| Laundromats | 2,190 |

Table 3‑45 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 3‑46 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.029 | [413] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Non-Energy Impacts

Measure Life

The effective useful life (EUL) for a multifamily common area is 11.3 years. The EUL for laundromats is 7.1 years. [413]

References

1. 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>
2. 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 .
3. 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>.
4. 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>
5. 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>
6. 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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑47 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| CyclesAnnual | Number of dryer cycles per year | Site-specific. If unknown, look up in Table 3‑49 | Cycles | [419] |
| Load | Average total weight of clothes per drying cycle | Look up in Table 3‑48 | lbs | [419] |
| Felec,b | Percentage of energy consumed that is derived from electricity for baseline dryer | Look up in Table 3‑48 | % | [425][426] |
| Felec,q | Percentage of energy consumed that is derived from electricity for efficient dryer | Look up in Table 3‑48 | % | [425][426] |
| Ffuel,b | Percentage of energy consumed that is derived from fossil fuel for baseline dryer | Look up in Table 3‑48 | % | [425][426] |
| Ffuel,q | Percentage of energy consumed that is derived from fossil fuel for efficient dryer | Look up in Table 3‑48 | % | [425][426] |
| CEFb | Combined energy factor for baseline dryer | Look up in Table 3‑48 | lb/kWh | [421] |
| CEFq | Combined energy factor for efficient dryer | Look up in Table 3‑48 | lb/kWh | [420] |
| Hrs | Annual run hours of clothes dryer | Site-specific. If unknown look up in Table 3‑49 | Hrs/yr | [419][424] |
| CF | Electric coincidence factor | Look up in Table 3‑50 | N/A | [422] |
| PDF | Gas peak day factor | Look up in Table 3‑50 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑48 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 |
| Felec,b[[95]](#footnote-97) | 0.16 | 1.00 | 1.00 | 1.00 | 1.00 |
| Felec,q | 0.16 | 1.00 | 1.00 | 1.00 | 1.00 |
| Ffuel,b[[96]](#footnote-98) | 0.84 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ffuel,q | 0.84 | 0.00 | 0.00 | 0.00 | 0.00 |
| CEFb | 3.30 | 3.73 | 3.61 | 3.27 | 2.55 |
| CEFq | 3.48 | 3.93 | 3.80 | 3.45 | 2.68 |
| Energy Star Most Efficient CEFq |  | 4.3 | 4.3 | 4.3 | 3.7 |

Table 3‑49 Annual Dryer Cycles

|  |  |  |
| --- | --- | --- |
| Facility Type | Commercial – Multifamily | Laundromat |
| CyclesAnnual | 1,241 | 2,190 |
| Hrs[[97]](#footnote-99) | 1,158 | 2,044 |

Peak Factors

Table 3‑50 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.029 | [422] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 12 years [423].

References

1. 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>
2. *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>
3. 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>
4. *Mid-Atlantic Technical Reference Manual (TRM) V10.* (2020), <https://neep.org/sites/default/files/media-files/trmv10.pdf>
5. 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>
6. Northwest Energy Efficiency Alliance (NEEA), ‘Dryer Field Study’, November 2014 <https://ecotope-publications-database.ecotope.com/2014_005_1_DryerStudy.pdf>
7. *Mid-Atlantic Technical Reference Manual (TRM) V10* (2020). <https://neep.org/sites/default/files/media-files/trmv10.pdf>
8. 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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑51 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| NCycles | Number of dryer cycles per year | Site-specific. If unknown,  look up in Table 3‑52 | Cycles/yr | [427] |
| SF | Savings factor | 0.18 | Therms/cycle | [428][427] |
| PDF | Gas peak day factor | Look up in Table 3‑53 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑52 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 3‑53 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[427].

References

1. *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>
2. 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.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑54 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
|  | Annual electric savings | Calculated | kWh/yr |  |
|  | Annual fue savings compared to existing unit | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings compared to existing unit | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| V | Refrigerator volume | Site-specific | ft3 |  |
| 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 |  |
| kWhq | Annual energy consumption of qualifying efficient unit | Look up in Table 3‑57 | kWh | [430] |
| kWhb | Annual energy consumption of code-compliant baseline unit | Site-specific or look up in Table 3‑56, Table 3‑57 | kWh | [429] |
| HVACc | HVAC interaction factor for annual electric energy consumption | 0.080 | N/A |  |
| HVACd | HVAC interaction factor for peak demand at utility summer peak hour | 0.175 | N/A |  |
| HVACff | 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 3‑58 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑58 | 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 3‑55 Daily Energy Consumption of Code-Compliant Baseline Unit

|  |  |
| --- | --- |
| Product Class | Daily Refrigerator Energy (kWhb ) |
| 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 3‑56 Daily Energy Consumption of Existing Unit

|  |  |  |
| --- | --- | --- |
| Product Class | Daily Refrigerator Energy when existing unit was manufactured before 03/26/2017 (kWhex) | Daily Refrigerator Energy when existing unit was manufactured after 03/27/2017 (kWhex) |
| **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 3‑57 Daily Energy Consumption of Qualifying Efficient Unit

|  |  |
| --- | --- |
| Product Class | Daily Refrigerator Energy (kWhq) |
| **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 3‑58 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 3‑59 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Commercial Reach-in Refrigerator | 12 | Site-specific. If unknown use 4 years | [432] |

References

1. Code of Federal Regulations, Energy Efficiency Program for Certain Commercial and Industrial Equipment, title 10, sec. 431.66 (2010).
2. ENERGY STAR Program Requirements Product Specification for Commercial Refrigerators and Freezers Eligibility Criteria Version 5.0, ENERGY STAR ®, December 2022.
3. Code of Federal Regulations, Energy Efficiency Program for Certain Commercial and Industrial Equipment, title 10, sec. 431.66 (2013).
4. 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>

### 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 [433]. 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Time of Sale (compared to code baseline):

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑60 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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| V | Freezer unit volume | Site-specific | ft3 |  |
| 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 |  |
| kWhq | Annual energy consumption of qualifying efficiency unit | Site-specific. If unknown, look up in Table 3‑62 | kWh/yr | [435] |
| kWhb | Annual energy consumption of code-compliant baseline unit | Site-specific or look up in Table 3‑61, Table 3‑62 | kWh/yr | [433] |
| CF | Electric coincidence factor | Look up in Table 3‑64 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑64 | N/A |  |
| HVACc | HVAC interaction factor for annual electric energy consumption | 0.080 | N/A |  |
| HVACd | HVAC interaction factor for peak demand at utility summer peak hour | 0.175 | N/A |  |
| HVACff | 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 3‑61 Current Federal Standard Baseline Equipment Daily Energy Consumption

|  |  |  |
| --- | --- | --- |
| Type | Freezer | |
| **Solid Door** | **Transparent Door** |
| Vertical |  |  |
| Horizontal |  |  |

Table 3‑62 Energy Star Equipment Daily Energy Consumption

|  |  |  |  |
| --- | --- | --- | --- |
| Volume (ft3) | Vertical Closed Freezer | | Horizontal Closed Freezer |
| **Solid Door** | **Transparent Door** | **Solid or Transparent Door** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Table 3‑63 Existing Equipment Daily Energy Consumption

|  |  |  |
| --- | --- | --- |
| Type | Freezer | |
| **Solid Door** | **Transparent Door** |
| Manufactured after 03/27/2017 | | |
| Vertical |  |  |
| Horizontal |  |  |
| Manufactured before 03/27/2017 | | |
| Vertical |  |  |
| Horizontal |  |  |

Peak Factors

Table 3‑64 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1 | [433] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

Table 3‑65 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Freezer | 12 | Site-specific. If unknown, use 4 years | [434] |

References

1. 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>
2. 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, *Effective/Remaining Useful Life Values*, California Public Utilities Commission (December 16, 2008).
3. ENERGY STAR® Program Requirements Product Specification for Commercial Refrigerators and Freezers, Eligibility Criteria Version 5.0. (2022).

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑66 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 | [436] |
| IEFb | Basline Integrated Energy Factor | Look up in Table 3‑67 & Table 3‑68 | liters/kWh | [437] |
| IEFq | Energy Efficient Integrated Energy Factor | Site-specific. If unknown, look up in Table 3‑69 & Table 3‑70 | liters/kWh | [438] |
| 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 | [439] |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑67 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 |
| ≥50.01 | 2.80 |

Table 3‑68 Whole-Home (Ducted) Dehumidifiers Baseline Integrated Energy Factor

|  |  |
| --- | --- |
| Product Case Volume (ft3) | Integrated Energy Factor (liters/kWh) |
| ≤ 8.0 | ≥1.77 |
| > 8.0 | ≥2.41 |

Table 3‑69 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 3‑70 Whole-Home (Ducted) 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 3‑71 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 [440].

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

Table 3‑72 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Dehumidifier | 12 | 4 | [440] |

References

1. “ENERGY STAR Appliance Calculator”. <https://www.energy.gov/energysaver/maps/appliance-energy-calculator>. n.d. Accessed December 21, 2022.
2. 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)>
3. ENERGY STAR® Program Requirements Product Specification for Dehumidifiers, Eligibility Criteria Version 5.0, October 2019.
4. 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.
5. 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>

### Room Air Conditioner

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/DI |
| Baseline | Code/Dual |
| End Use Subcategory | Indoor Environment |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑73 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Cap | Cooling capacity of efficient equipment | Site-specific | Btu/hr |  |
| EFLHc | 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 | [441] |
| CEERb | Efficiency of baseline unit | EREP/DI: Site-specific existing efficiency, if unknown look up vintage code in in Appendix E: Code-Compliant Efficiencies TOS: Look up current code in Appendix E: Code-Compliant Efficiencies | Btu/hr/watt | [442] |
| CEERq | Efficiency of efficient unit | Site specific or defaults in lookup in Table 3‑74 | Btu/hr/watt | [443] |
| CF | Electric coincidence factor | Look up in Table 3‑75 | 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 3‑74 ENERGY STAR CEER values for room air conditioner

|  |  |  |  |
| --- | --- | --- | --- |
| Product Type and Class (Btu/hour) | | ENERGY STAR with louvered sides (CEER) | ENERGY STAR without louvered sides (CEER) |
| Without reverse cycle | <6,000 | 12.1 | 11.0 |
| 6,000 to 7,999 | 12.1 | 11.0 |
| 8,000 to 10,999 | 12.0 | 10.6 |
| 11,000 to 13,999 | 12.0 | 10.5 |
| 14,000 to 19,999 | 11.8 | 10.2 |
| 20,000 to 27,999 | 10.3 | 10.3 |
| ≥28,000 | 9.9 | 10.3 |
| With reverse cycle | <14,000 | N/A | 10.2 |
| ≥14,000 | N/A | 9.6 |
| <20,000 | 10.8 | N/A |
| ≥20,000 | 10.2 | N/A |
| Casement-only[[98]](#footnote-100) | | 10.5 | |
| Casement slider[[99]](#footnote-101) | | 11.4 | |

Peak Factors

Table 3‑75 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.31 | [444] |
| 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 3‑76 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Room Air Conditioner | 9 | 3 | [445] |

References

1. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.
2. 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>
3. 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>
4. 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>

1. PA TRM Energy Efficiency and Conservation Programs (TRM), Version 9, January 2023.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑77 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Hr | Annual hours of operation | Site-specific, if unknown assume 8,760 | Hrs |  |
| kWhb | Energy use of baseline water cooler | Look up in Table 3‑78 | kWh/day | [446] |
| kWhq | Energy use of energy efficient water cooler | Site-specific, if unknown look up in Table 3‑78 | kWh/day | [447] |
| CF | Electric coincidence factor | Look up in Table 3‑79 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑79 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑78 Water Cooler Energy Use

|  |  |  |
| --- | --- | --- |
| Energy Star Water Cooler Type Product Capacity Class, and Conditioning Method | Baseline kWhb (kWh/day) | Default Efficient kWhq (kWh/day) |
| Cold Only | 0.16 | 0.16 |
| Hot & Cold – Low Capacity[[100]](#footnote-102) | 0.87 | 0.68 |
| Hot & Cold – High Capacity[[101]](#footnote-103) | 0.87 | 0.80 |
| Hot & Cold On-Demand | 0.18 | 0.18 |

Peak Factors

Table 3‑79 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1.0 | [448] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 10 years. [446]

References

1. ENERGY STAR Product Specifications for Water Coolers Version 2.0. <https://www.energystar.gov/sites/default/files/specs//ES%20WC%20V2%200%20Spec.pdf>
2. 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>
3. Assumes 24/7 operation. Site-specific load shape information should be used if known.

## Appliance Recycling

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑80 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔkWh/unit | Energy Savings | Lookup in Table 3‑81 | kWh | [450] |
| ΔkW/unit | Demand Savings per unit | Lookup in Table 3‑81 | kWh | [450] |
| CF | Electric coincidence factor | Look up in Table 3‑82 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑82 | N/A |  |
| EUL | Effective useful life | See | Years | [449] |

Table 3‑81 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 3‑82 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 [449].

References

1. 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. 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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑83 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Btu/h | Capacity of replaced unit | Site-specific, if unknown assume 8,500 | Btu/hr | [453] |
| EER | Efficiency of existing unit | Site-specific, if unknown assume 9.8 | Btu/W/hr | [454] |
| Hrs | Run hours of A/C unit | Site-specific, if unknown assume 325 | Hours | [452] |
| 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 | [457] |
| CF | Electric coincidence factor | Look up in Table 3‑84 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑84 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 3‑84 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.3 | [453] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 3 years. [451]

References

1. 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. 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.”
3. 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>
4. 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.
5. 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.
6. *Mid-Atlantic TRM Manual: Version 10* (NEEP, 2020), Pg 110 <https://neep.org/mid-atlantic-technical-reference-manual-trm-v10>.
7. Cadmus analysis, EmPOWER 2018 P1 & P2 ARP participant survey

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑85 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Capacity | Capacity of the unit | Site-specific. If unknown, use 56 | pints/day | [464] |
| L/kWh | Dehumidifier Efficiency | Look up in Table 3‑86 | L/kWh | [459][461][462] |
| 0.473 | Conversion factor | 0.473 | L/pint |  |
| 24 | Conversion factor | 24 | Hr/day |  |
| Hrs | Hours of use | 1632 | Hours | [459] |
| CF | Electric coincidence factor | Look up in Table 3‑87 | N/A |  |
| PDF | Gas peak day factor | Look up inTable 3‑87 | N/A |  |
| RUL | Remaining useful life | See Measure Life Section | Years |  |

Table 3‑86 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 |
| >75 to ≤ 185 | 3.30 | 2.25 | 2.50 |

Peak Factors

Table 3‑87 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.405 | [463] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The remaining useful life (RUL) is 4 years [458].

References

1. 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.
2. Savings Calculator for ENERGY STAR® Qualified Appliances Version 3.0 Last Updated October 1, 2012.
3. ENERGY STAR® Program Requirements for Dehumidifiers, Version 5.0, February 2019.
4. 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>
5. 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>
6. 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.
7. *Mid-Atlantic Technical Reference Manual (TRM) V10.* (2020), <https://neep.org/sites/default/files/media-files/trmv10.pdf>

## Foodservice

### 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 [466] – 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 [470].
* Rack Ovens [466] – 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 [467] – 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 [468]– 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 [469] – 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 [471].

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.[[102]](#footnote-104) Preheat energy and all values for half size gas convection ovens, conveyor ovens and griddles are reported from referenced FSTC sources.

Table 3‑88 Equipment Baselines Case Default Characteristics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Equipment | Btupreheat,baseline  (Btu) | Btu/hidle,baseline  (Btu/h) | (lbs/hr)baseline | Effbaseline | Ref |
| Convection Oven, Electric, Full Size | 5,118 | 5,459 | 70 | 0.71 | [470][466] |
| Convection Oven, Electric, Half Size | 3,412 | 3,412 | 45 | 0.71 | [470][466] |
| Convection Oven, Gas, Full Size | 19,000 | 12,000 | 70 | 0.46 | [470][466] |
| Convection Oven, Gas, Half Size | 13,000 | 12,000 | 45 | 0.30 | [470] |
| Conveyor Oven, Gas | 21,270 | 55,000 | 114 | 0.30 | [480] |
| Rack Oven, Gas, Double Rack | 100,000 | 30,000 | 250 | 0.52 | [472][466] |
| Rack Oven, Gas, Single Rack | 50,000 | 25,000 | 130 | 0.48 | [476][466] |
| 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 | [467][473] |
| Steamer, Gas | 20,000 | 3-pan: 6,250  4-pan: 8,350  5-pan: 10,400  6-pan and larger: 12,500 | 23.3 x No. of pans | 0.38 | [467][473] |
| Fryer, Electric | 8,189 | 3,412 | 65 | 0.80 | [474][481] |
| Fryer, Gas | 18,500 | 9,000 | 60 | 0.50 | [474][481] |
| Griddle, Electric | 4,436 x Griddle Width (ft) | 2,730 x Griddle Width (ft) | 11.7 x Griddle Width (ft) | 0.60 | [475] |
| Griddle, Gas | 7,000 x Griddle Width (ft) | 7,000 x Griddle Width (ft) | 8.4 x Griddle Width (ft) | 0.30 | [475] |

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 3‑89.

Table 3‑89 Equipment Efficient Case Default Characteristics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Equipment | Btupreheat,ee  (Btu) | Btu/hidle,ee  (Btu/h) | (lbs/hr)ee | Effee | Ref |
| Convection Oven, Electric, Full Size | 3,412 | 4,606 | 82 | 0.76 | [470][482] |
| Convection Oven, Electric, Half Size | 3,071 | 2,593 | 53 | 0.76 | [470][482] |
| Convection Oven, Gas, Full Size | 11,000 | 9,349 | 82 | 0.51 | [470][482] |
| Convection Oven, Gas, Half Size | 7,500 | 4,293 | 53 | 0.53 | [470][482] |
| Conveyor Oven, Gas | 15,000 | 40,000 | 158 | 0.46 | [471][480] |
| Rack Oven, Gas, Double Rack | 85,000 | 24,600 | 280 | 0.56 | [472][483] |
| Rack Oven, Gas, Single Rack | 44,000 | 19,733 | 140 | 0.51 | [476][483] |
| Steamer, Electric | 5,118 | 990 | 14.7 x No. of pans | 0.70 | [473][484] |
| Steamer, Gas | 9,000 | 1,221 | 20.8 x No. of pans | 0.47 | [473][484] |
| Fryer, Electric, Standard | 6,483 | 2,327 | 71 | 0.86 | [474][485] |
| Fryer, Gas, Standard | 16,000 | 7,571 | 67 | 0.52 | [474][485] |
| Griddle, Electric | 2,389 x Griddle Width (ft) | 1,000 x Griddle Area (ft2) | 16.3 x Griddle Width (ft) | 0.75 | [475] |
| Griddle, Gas | 5,000 x Griddle Width (ft) | 2,068 x Griddle Area (ft2) | 16.4 x Griddle Width (ft) | 0.46 | [475] |

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Where:

NOTE: ΔBtupreheat, ΔBtuidle and ΔBtucooking 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 3‑92.

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔBtupreheat | Daily preheat energy savings | Calculate based on calculations above or look up in Table 3‑92 | Btu |  |
| ΔBtuidle | Daily idle energy savings | Calculate based on calculations above or look up in Table 3‑92 | Btu |  |
| ΔBtucooking | Daily cooking energy savings | Calculate based on calculations above or look up in Table 3‑92 | Btu |  |
| days | Operating days per year | Site-specific, if unknown look up based on facility type in Table 3‑91 | Btu |  |
| hrs | Daily operating hours | Site-specific, if unknown look up based on facility type in Table 3‑91 | hours |  |
| Btupreheat,baseline | Basline Equipment preheat energy | Look up based on qualifying equipment type in Table 3‑88 | Btu |  |
| Btupreheat,ee | Energy Efficient Equipment preheat energy | Site-specific, if unknown look up based on qualifying equipment type in Table 3‑89 | Btu |  |
| Npreheat | Number of preheats per day | 1 |  |  |
| hrspreheat | Preheat duration | Look up based on qualifying equipment type in  Table 3‑93 | hours |  |
| Btu/hidle,baseline | Baseline Equipment idle energy rate | Look up based on qualifying equipment type in Table 3‑88 | Btu/h |  |
| Btu/hidle,ee | Energy Efficient Equipment idle energy rate | Site-specific, if unknown look up based on qualifying equipment type in Table 3‑89 | Btu/h |  |
| (lbs/hr)baseline | Baseline Equipment production capacity | Look up based on qualifying equipment type in Table 3‑88 | lbs/hr |  |
| (lbs/hr)ee | Energy Efficient Equipment production capacity | Site-specific, if unknown look up based on qualifying equipment type in Table 3‑89 | lbs/hr |  |
| lbs | Total daily food production | Site-specific, if unknown look up based on qualifying equipment type in  Table 3‑93 | lbs |  |
| Qfood | Heat to food | Look up based on qualifying equipment type in  Table 3‑93 | Btu/lb |  |
| Effbaseline | Baseline Equipment convection/steam mode cooking efficiency | Look up based on qualifying equipment type in Table 3‑88 | N/A |  |
| Effee | Energy Efficient Equipment convection/steam mode cooking efficiency | Site-specific, if unknown look up based on qualifying equipment type in Table 3‑89 | N/A |  |
| CF | Electric coincidence factor | Lookup in Table 3‑94 | N/A | [486] |
| PDF | Gas peak day factor | Lookup in Table 3‑94 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑91 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 3‑92 contains values and simplified calculations for ΔBtupreheat, ΔBtuidle and ΔBtucooking 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 3‑92 Default Values

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | ΔBtupreheat | ΔBtuidle | ΔBtucooking |
| 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[[103]](#footnote-105) | 0 | 1740 x hrs - 3201 | 6,000 |
| Steamer, Gas[[104]](#footnote-106) | 11,000 | 11279 x hrs - 10783 | 5,291 |
| Fryer, Electric, Standard | 1,706 | 1085 x hrs - 3229 | 7,456 |
| Fryer, Gas, Standard | 2,500 | 1429 x hrs - 5906 | 6,577 |
| Griddle, Electric[[105]](#footnote-107) | 6,141 | 2190 x hrs - 11611 | 15,833 |
| Griddle, Gas[[106]](#footnote-108) | 6,000 | 8592 x hrs - 60262 | 55,072 |

Table 3‑93 Common Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equipment | hrspreheat | lbs | Qfood(Btu/lb) | Ref |
| Convection Oven, Electric, Full Size | 0.25 | 100 | 250 | [470] |
| Convection Oven, Electric, Half Size | 0.25 | 100 | 250 | [470] |
| Convection Oven, Gas, Full Size | 0.25 | 100 | 250 | [470] |
| Convection Oven, Gas, Half Size | 0.25 | 100 | 250 | [470] |
| Conveyor Oven, Gas | 0.25 | 190 | 250 | [471] |
| Rack Oven, Gas, Double Rack | 0.33 | 1200 | 235 | [472] |
| Rack Oven, Gas, Single Rack | 0.33 | 600 | 235 | [472] |
| Steamer, Electric | 0.25 | 100 | 105 | [472] |
| Steamer, Gas | 0.25 | 100 | 105 | [473] |
| Fryer, Electric, Standard | 0.25 | 150 | 570 | [474] |
| Fryer, Gas, Standard | 0.25 | 150 | 570 | [474] |
| Griddle, Electric | 0.25 | 100 | 475 | [475] |
| Griddle, Gas | 0.25 | 100 | 475 | [475] |

Peak Factors

Table 3‑94 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.9 | [486] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 12 years[[107]](#footnote-109).

References

1. ENERGY STAR® Commercial Food Service Calculator, <https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products>
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3. 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>
4. 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>
5. 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>
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7. Pacific Gas & Electric Company, Work Paper PGECOFST117 Commercial Conveyor Oven-Gas, Revision 5, May 2014
8. Pacific Gas & Electric Company, Work Paper PGECOFST109 Commercial Rack Oven-Gas, Revision 1, October 2018
9. Pacific Gas & Electric Company, Work Paper PGECOFST104 Commercial Steam Cooker-Electric and Gas, Revision 6, June 2016
10. Pacific Gas & Electric Company, Work Paper PGECOFST102 Commercial Fryer-Electric and Gas, Revision 6, June 2016
11. California Technical Forum, Work Paper SWFS004, Commercial Griddle-Electric and Gas, Revision 1, January 2020, available at <http://deeresources.net/workpapers>
12. Food Service Technology Center: Gas Rack Oven Life-Cycle Cost Calculator, <https://caenergywise.com/calculators/natural-gas-rack-ovens/#calc>
13. Food Service Technology Center: Electric Fryer Life-Cycle Cost Calculator, <https://caenergywise.com/calculators/electric-fryers/#calc>
14. Food Service Technology Center: Gas Fryer Life-Cycle Cost Calculator, <https://caenergywise.com/calculators/natural-gas-fryers/#calc>
15. 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>
16. California Public Utilies Commission, SWFS008, Conveyor Oven, Gas, Commercial, Revision 1, January 2020 available at [Ex Ante Database Archive (deeresources.net)](http://deeresources.net/workpapers)
17. 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>
18. California Public Utilies Commission, SWFS001 Commercial Covection Oven – Electric and Gas, Revision 2, May 2020 available at [Ex Ante Database Archive (deeresources.net)](http://deeresources.net/workpapers)
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20. California Public Utilies Commission, SWFS005 Commercial Steam Cooker, Revision 2, May 2020 available at [Ex Ante Database Archive (deeresources.net)](http://deeresources.net/workpapers)
21. California Public Utilies Commission, SWFS011 Fryer,Commercial, Revision 4, March 2022 available at [Ex Ante Database Archive (deeresources.net)](http://deeresources.net/workpapers)
22. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs v10, effective date January 1, 2023.

### 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 ft3. Full-size holding cabinets are defined as any holding cabinet with an internal measured volume of greater than or equal to 13 ft3 and less than or equal to 28 ft3. Large-size holding cabinets are defined as any holding cabinet with an internal measure volume of greater than 28 ft3. 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 3‑95.

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

*Where,*

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑95 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔWidle | Daily idle energy savings | Calculated | Watt |  |
| Hrs | Daily operating hours | Site-specific. If unknown, use 15 | Hours/day | [489] |
| Days | Operating days per year | Site-specific. If unknown, look up in Table 3‑96 | Days/yr | [488] |
| 1,000 | Conversion factor, one kW equals 1,000 watts | 1,000 | Watts |  |
| Widle,b | Baseline equipment idle energy rate by volume | Look up in Table 3‑97 | Watts | [490] |
| Widle,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 3‑97 | ft3 | [491] |
| CF | Electric coincidence factor | Look up in Table 3‑98 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑98 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑96 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 3‑97 Default Values

|  |  |  |
| --- | --- | --- |
| Equipment | Widle,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 3‑98 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.9 | [489] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 12 years [487].

References

1. DEER 2014 EUL IDs: Various. <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>
2. California Energy Commission, Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Foodservice Equipment, Appendix E.
3. PG&E Work Paper PGECOFST105 Revision 5, pg. 7. Available to download at <http://deeresources.net/workpapers>
4. ENERGY STAR® Program Requirements for Commercial Hot Food Holding Cabinets, Eligibility Criteria Version 2.0, July 2011, where v is holding cabinet volume (ft3). <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>.
5. PG&E Work Paper PGECOFST105 Revision 5, Table 6, pg. 5.

### Dishwashers

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | TOS |
| Baseline | Code |
| End Use Subcategory | N/A |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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.[492]

Efficient Case

The efficient condition is a high-efficiency commercial dishwasher meeting ENERGY STAR Version 3.0 requirements. [493]

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

If electric booster heater installed:

If no electric booster heater installed:

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑99 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhWaterHeater | Annual water heater electric energy savings | Calculated | kWh/yr |  |
| ΔkWhBoosterHeater | Annual booster heater electric energy savings | Calculated | kWh/yr |  |
| ΔkWhIdle | Annual dishwasher idle electric energy savings | Calculated | kWh/yr |  |
| WUq | Water use per rack of qualifying dishwasher, varies by machine type and sanitation method | Site-specific | Gallons |  |
| kWq | Idle power draw of ENERGY STAR 3.0 dishwasher, varies by machine type and sanitation method | Site-specific | kW |  |
| Days | Annual days of dishwasher consumption per year | Site-specific, if unknown use 365 | Days/Year | [492] |
| WUb | Water use per rack of baseline dishwasher, varies by machine type and sanitation method | Look up in Table 3‑100 | Gallons | [493] |
| RW | Number of racks washed per day, varies by machine type and sanitation method | Look up in Table 3‑100 | Racks Washed/Day | [492] |
| ΔTin | 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 | [492] |
| RE | Recovery efficiency of water heater | Site-specific, if unknown use 0.98 for electric and 0.80 for gas |  | [492] |
| kWb | Idle power draw of baseline dishwasher, varies by machine type and sanitation method | Look up in Table 3‑100 | kW | [493] |
| HD | Hours per day of dishwasher operation | Site-specific, if unknown use 18 hours/day | Hours/Day | [492] |
| WT | Wash time per dishwasher, varies by machine type and sanitation method | Look up in Table 3‑100 | Minutes | [492] |
| H2Ob | Annual water consumption of baseline unit | Look up in Table 3‑101 | gallons | [492] |
| H2Oq | Annual water consumption of efficient unit | Look up in Table 3‑101 | gallons | [492] |
| FElec,WH | Factor to account for building water heat | If building water heat is electric: 1  If building water heat is not electric: 0  If unknown: 0.28 |  |  |
| FFF,WH | Factor to account for fossil fuel building water heat | If building water heat is electric: 0  If building water heat is not electric: 1  If unknown: 0.79 |  |  |
| 8.2 | Density of Water | 8.2 | Lbs/gal | [494] |
| 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 3‑102 | N/A | [495] |
| PDF | Gas peak day factor | Look up in Table 3‑102 | N/A |  |
| EUL | Effective useful life | See Measure Life | Years |  |

Table 3‑100 Default Inputs for ENERGY STAR 2.0 Commercial Dishwasher

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Machine Type | Temperature |  | RW | WT |  |
| 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 |
| 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 3‑101 Annual Water Consumption

|  |  |  |  |
| --- | --- | --- | --- |
| Machine Type | Temperature | H2Ob | H2Oq |
| 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 3‑102 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.9 | [495] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Non-Energy Impacts

Measure Life

The effective useful life (EUL) is listed in Table 3‑103 [492].

Table 3‑103 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

1. ENERGY STAR Savings Calculator for Certified Commercial Kitchen Equipment. <http://www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx>
2. ENERGY STAR Program Requirements for Commercial Dishwashers Version 2.0, ENERGY STAR, February 2013.
3. Dishwasher inlet temperature assumed at 140 degrees F. <https://water.usgs.gov/edu/density.html>.
4. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs v10, effective date January 1, 2023.

### 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 [496].

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 [497] and continuous type [497] ice makers, as specified in the Code of Federal Regulations and provided in Table 3‑105.

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 3‑105 [498]. An efficient ice maker also needs to meet the potable water consumption requirement as shown in Table 3‑105 [498].

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑104 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWhb | Baseline electric energy consumption per 100 pounds of ice | Look up in Table 3‑105 | kWh/lbs | [497] |
| kWhq | Energy efficient electric energy consumption per 100 pounds of ice | Site-specific. If unknown, look up in Table 3‑105 | kWh/lbs | [498] |
| 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 | [500] |
| 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 3‑106 | N/A | [499] |
| PDF | Gas peak day factor | Look up in Table 3‑106 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [501] |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 3‑105 Equipment Type and Ice Harvest Rate

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equipment Type | Ice Harvest Rate (IHR) | Baseline Daily Energy Use per 100 ilbs (kWhb) | Measure Daily Energy Use per 100 lbs (kWhq) | 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 |
| Continuous Type, Self-Contained | < 200 | 14.22 – 0.03 x IHR | 12.37 – 0.0261 x IHR | ≤ 15.0 |
| ≥ 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 3‑106 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.9 | [499] |
| 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 3‑107 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Ice Machines | 10 | 3.3 | [501] |

References

1. “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>
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4. Pacific Gas & Electric Work Paper SWFS SWFS006-01 Commercial Ice Machines, January 2020, pg. 12. [www.deeresources.net/workpapers](http://www.deeresources.net/workpapers)
5. Pacific Gas & Electric Work Paper SWFS SWFS006-01 Commercial Ice Machines, January 2020, pg. 9. [www.deeresources.net/workpapers](http://www.deeresources.net/workpapers)
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## HVAC

### Air Conditioner, Mini-Split AC, and PTAC

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/EREP/DI |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version | * Removed reference to specific ENERGY STAR certification in efficient case description |

Description

This measure targets the use of air conditioners and packaged terminal air conditioners (PTAC) 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 as outlined in Table 3‑113, Table 3‑109 and Table 3‑110 below.

Baseline Case

For time of sale or new construction projects, the baseline equipment is an air conditioner or packaged terminal system (PTAC) minimally compliant with ASHRAE 90.1-2019 (see Appendix E).

For early replacement or direct install 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 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).
* 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.

Efficient Case

A air conditioner or packaged terminal system (PTAC) that meets meets or exceeds program requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Calculate kWhb using the algorithms in Table 3‑113 for the appropriate baseline equipment type.

Calculate kWhq using the algorithms in Table 3‑114 for the appropriate efficient equipment type.

Note: Conversions from SEER to SEER2 and EER to EER2 can be found in Appendix E.

Table 3‑108 Baseline Energy Consumption Equations

|  |  |
| --- | --- |
| Baseline Equipment | Baseline Cooling kWh (kWhb) |
| Air Conditioner (Cooling Capacity < 65 kBtu/h) |  |
| Air Conditioner (Cooling Capacity ≥ 65 kBtu/h) |  |
| PTAC |  |

Table 3‑109 Energy Efficient Energy Consumption Equations

|  |  |
| --- | --- |
| Qualifying Equipment | Efficient Cooling kWh (kWhq) |
| Air Conditioner (Cooling Capacity < 65 kBtu/h) |  |
| Air Conditioner (Cooling Capacity ≥ 65 kBtu/h) |  |
| PTAC |  |

Peak Demand Savings

Table 3‑110 Peak Demand Savings Equations

|  |  |
| --- | --- |
| Qualifying Equipment | Peak Demand Savings (ΔkWPeak) |
| Air Conditioner (Cooling Capacity < 65 kBtu/h) |  |
| Air Conditioner (Cooling Capacity ≥ 65 kBtu/h) |  |
| PTAC |  |

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑111 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWhb | Baseline electrical consumption | Calculated | kWh/yr |  |
| kWhq | Energy efficient electrical consumption | Calculated | kWh/yr |  |
| Capc | Cooling capacity of installed unit | Site-specific | Btu/hr |  |
| SEER2q | SEER2 of qualifying unit[[108]](#footnote-110) | Site-specific | Btu/W-h |  |
| IEERq | IEER of qualifying unit | Site-specific | Btu/W-h |  |
| EERq | EER of qualifying unit | Site-specific | Btu/W-h |  |
| EER2q | EER of qualifying unit | Site-specific | Btu/W-h |  |
| SEER2b | SEER2 of baseline unit1 | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or ASHRAE 2013 if vintage is unknown | Btu/W-h | [509][511] |
| IEERb | IEER of baseline unit | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or ASHRAE 2013 if vintage is unknown | Btu/W-h | [509][511] |
| EERb | EER of baseline unit | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or ASHRAE 2013 if vintage is unknown | Btu/W-h | [509][511] |
| EER2b | EER2 of baseline unit | TOS/NC: Look up in Appendix E for current code-compliant efficiency  EREP/DI: Site-specific, if unknown use code efficiency in force when equipment was new or ASHRAE 2013 if vintage is unknown | Btu/W-h |  |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Look up in Appendix C | Hours | [512] |
| 1,000 | Conversion from hp to Kw | 1,000 | w/kW |  |
| CF | Electric coincidence factor | 0.5 | N/A | [513] |
| EUL | Effective useful life | See Measure Life Section | Years | [514] |

Measure Life

For dual baseline scenarios, the remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

Table 3‑112 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| A/C and PTAC | 15 | 5 | [514] |

References

1. 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](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)
2. 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
3. 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
4. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
5. 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.
6. 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>
7. Code of Federal Regulations. 2022. Review of Title 10, Chapter II, Subchapter D, Part 430, Subpart C, section 430.32 b) Room Air Conditioners,

### Air Source Heat Pumps and Mini-Split Heat Pumps

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/EREP/DI |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | May 2024 |
| Changes Since Last Version | * Clarified guidance on baselines assumptions for midstream applications: when to assume partial vs. whole displacement and fuel-switching vs. non-fuel switching * Removed reference to specific ENERGY STAR certification in efficient case description |

Description

This prescriptive measure targets the use of air source heat pumps (ASHP) and mini split heat pumps in commercial and multifamily high-rise applications. 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.

In certain instances, air source heat pumps and mini-split heat pumps may only partially meet the heating load, requiring a supplementary heating system to meet the facility’s full heating load. As such, this measure presents two displacement scenarios: partial and whole.

* **Partial displacement:** the heat pump fulfils a portion of the facility’s heating load. Partial displacements occur in either of the two scenarios: 1) the installation of a heat pump that shares the facility’s heating load with a separate supplemental heating system or 2) the installation of a “dual fuel” heat pump that incorporates a backup fossil fuel furnace to supplement the heat pump output. Partial displacements are addressed in the equations below by a load factor parameter (Fload), which represents the actual heating output of the heat pump as compared to the total theoretical heating output.[[109]](#footnote-111) The partial displacement scenario only applies to heating displacement; this measure assumes that the installed heat pump will serve the entire cooling load of the zone(s) affected by the installation. If the installed heat pump is not a cold-climate heat pump, assume a partial displacement scenario unless there is evidence for a whole displacement installation (such as proof that any pre-existing heating systems were removed).
* **Whole displacement:** the heat pump and any integrated supplemental resistance meets the facility’s entire heating load, with no supplemental equipment. May assume whole displacement scenario if the installed heat pump is a cold-climate heat pump.

This measure does not accommodate the interactive effects of concurrent weatherization upgrades.

Note: Measures in common areas of high-rise multifamily buildings (more than three stories) follow commercial protocol presented in this measure. 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 a unitary packaged or split-system heat pump meeting the compliance requirements of ASHRAE 90.1-2019 for commercial and multifamily high-rise buildings (see Appendix E: Code-Compliant Efficiencies). For multifamily low-rise buildings (three stories or lower), refer to residential measure (Section 3.3.1).

**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. If the baseline system fuel is unknown, such as in a midstream delivery method, calculate savings using a gas baseline (fuel switching project, assume 37% boilers and 63% furnaces as baseline equipment, per NREL ComStock data for New Jersey) and electric baseline (non fuel switching project, assume ASHP as baseline equipment) and calculate the weighted average using the weights in the table below.[[110]](#footnote-112)

|  |  |  |
| --- | --- | --- |
|  | Fuel switch | Non fuel switch |
| ACE | 0.13 | 0.87 |
| JCPL | 0.22 | 0.78 |
| RECO | 0.01 | 0.99 |
| PSEG | 0.61 | 0.39 |
| **Average** | **0.24** | **0.76** |

**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 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.

**For spaces with no existing heating:** For previously unheated spaces in an existing building that has an existing central heating system, the customer may have planned to install a heat pump regardless of program intervention, or the customer may have planned to extend the existing central HVAC system to heat the new space. The baseline can therefore vary between a new equipment scenario and a retrofit scenario. For such installations, the baseline energy consumption algorithm is designed to blend the baseline energy consumptions of the new equipment scenario and retrofit scenario using a baseline factor, Fbaseline,h.[[111]](#footnote-113)

* New equipment scenario: absent the program, the customer would have purchased new heating equipment instead of extending the existing central heating system. The new equipment scenario baseline is a code-compliant air-source heat pump of the same size as the installed heat pump.
* Retrofit scenario: absent the program, the customer would have extended the existing central heating system instead of purchasing new heating equipment. The retrofit scenario baseline is the existing central heating equipment.

**For spaces with no existing cooling:** For buildings without existing cooling, or spaces without cooling in an existing home that has an existing central cooling system, the customer may have planned to install a cooling regardless of program intervention, or the customer may have planned to leave the space without any cooling. The baseline can therefore vary between a new load scenario and a non-new load scenario. For such installations, the baseline energy consumption algorithm is designed to blend the baseline energy consumptions of the new equipment scenario and retrofit scenario using a baseline factor, Fbaseline,c.[[112]](#footnote-114)

* New load scenario: absent the program, the customer would not install any cooling. The new load scenario baseline is no existing cooling.
* Non-new load scenario: absent the program, the customer would have added cooling to the space. The non-new load scenario cooling baseline is the existing central cooling system if one exists, or a code-compliant air conditioner of the same cooling capacity as the installed heat pump.

Efficient Case

An air source heat pump or mini split heat pump that meets or exceeds program eligibility requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

For partial displacement applications,

If supplemental heat is an existing electric resistance heating system:

If supplemental heat is an existing fossil fuel system:

For whole displacement applications,

Calculate kWhc,b, kWhh,b, Kwhsupplement using the algorithms in Table 3‑113 for the appropriate baseline and supplemental equipment type, if applicable.

Calculate kWhc,q and kWhh,q using the algorithms in Table 3‑114 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 3‑113 Baseline Electric Energy Consumption Equations

|  |  |  |
| --- | --- | --- |
| Baseline Equipment | Cooling kWh (kWhc,b) | Heating kWh (kWhh,b or kWhsupplement) |
| No existing cooling |  | N/A |
| No existing heating, central fossil fuel system | N/A |  |
| No existing heating, central electric resistance/electric furnace | N/A |  |
| Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h) or whole building new construction |  |  |
| ASHP (Cooling Capacity > 65 kBtu/h & IEER Available) |  |  |
| ASHP (Cooling Capacity > 65 kBtu/h & IEER not available) |  |  |
| Air Source Air Conditioner (Cooling Capacity < 65 kBtu/h) |  | N/A |
| Air Source Air Conditioner (Cooling Capacity > 65 kBtu/h & IEER Available) |  | N/A |
| Air Source Air Conditioner (Cooling Capacity > 65 kBtu/h & IEER not available) |  | N/A |
| PTAC with electric resistance heat |  |  |
| PTAC with fossil fuel heat |  | N/A |
| PTHP |  |  |
| Electric resistance/electric furnace heating | N/A |  |
| Room Air Conditioner |  | N/A |

Table 3‑114 Energy Efficient Electric Energy Consumption Equations

|  |  |  |
| --- | --- | --- |
| Qualifying Equipment | Efficient Cooling kWh  (kWhc,q) | Efficient Heating kWh  (kWhh,q) |
| Mini-split heat pump, ASHP (Cooling Capacity < 65 kBtu/h) |  |  |
| ASHP (Cooling Capacity > 65 kBtu/h & IEER Available) |  |  |
| ASHP (Cooling Capacity > 65 kBtu/h & IEER not available) |  |  |
| PTHP |  |  |

Annual Fuel Savings

Where,

For partial displacement applications where the heat pump adds on to an existing fossil fuel system,

For partial displacement applications where a new supplemental fossil fuel heating system is installed,

For whole displacement applications,

Table 3‑115 Baseline Fossil Fuel Consumption

|  |  |
| --- | --- |
| Baseline Equipment | Baseline fuel consumption (Thermsb) |
| Fossil Fuel (Gas, Oil, Propane) Furnace/Boiler |  |
| No existing heating |  |

Table 3‑116 Energy Efficient Fossil Fuel Consumption

|  |  |
| --- | --- |
| Qualifying Equipment | Efficient fuel consumption (Thermsq,ff) |
| New Supplemental Fossil Fuel (Gas, Oil, Propane) Furnace/Boiler |  |

To calculate savings in gallons of delivered fuel, use Table 3‑200.

Table 3‑117 Fuel Savings in Gallons

|  |  |
| --- | --- |
| Delivered Fuel | Fuel savings (gallons) |
| Oil |  |
| Propane |  |

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Use single baseline for whole displacement new construction and replace on failure.

Use dual baseline for early replacement and addition to existing equipment. In both cases, the RUL is defined by the smaller of the pre-existing heating or cooling system RUL.

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑118 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔGalOil | Oil savings | Calculated | Gallons |  |
| ΔGalPropane | Propane savings | Calculated | Gallons |  |
| kWhb | Baseline electrical consumption | Calculated | kWh/yr |  |
| kWhq | Energy efficient electrical consumption | Calculated | kWh/yr |  |
| Capc | Cooling capacity of installed unit | Site-specific | Btu/hr |  |
| Caph | Heating capacity of installed heat pump heating equipment | Site-specific | Btu/hr |  |
| SEER2q | SEER2 of qualifying unit | Site-specific | Btu/W-h |  |
| IEERq | IEER of qualifying unit | Site-specific | Btu/W-h |  |
| EER2q | EER2 of qualifying unit | Site-specific | Btu/W-h |  |
| COPq | Coefficient of performance at 47F of the qualifying unit | Site-specific | N/A |  |
| HSPFq | Heating seasonal performance factor of the installed unit | Site-specific | Btu/W-h |  |
| SEER2b | SEER of baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [509][511] |
| IEERb | IEER of baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [509][511] |
| EER2b | EER2 of baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [509][511] |
| HSPF2b | Heating seasonal performance factor of the baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies. | Btu/W-h | [509][511] |
| CEERb | Combined Energy Efficiency Ratio of baseline room air conditioner[[113]](#footnote-115) | Use federal standard values in Appendix E: Code-Compliant Efficiencies. If unknown, use 11.0 | Btu/W-h | [515] |
| Effb,fuel | Efficiency of baseline boiler/furnace | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | N/A | [509][511] |
| Effq,fuel | Efficiency of newly installed supplemental boiler/furnace | Site-specific | N/A |  |
| OSF | Oversize derating factor[[114]](#footnote-116) | Site-specific, if unknown use 0.8 | N/A |  |
| Fload | Partial Displacement Factor to account for the portion of heating load met by the heat pump | Lookup in Table 2‑64, using switchover point of 35°F unless site-specific switchover point is known and documented | N/A | [88][90] |
| Fbaseline,h | Fraction of projects where, absent the program, the customer would have purchased new heating equipment for a previously unheated space instead of extending existing central system | If installed heat pump is a ductless minisplit: 0.18  If installed heat pump is a ducted ASHP: 0.27 | N/A | [521] |
| Fbaseline,c | Fraction of projects where, absent the program, the customer would not have installed cooling in previously uncooled space, so the added cooling represented added electrical load | If installed heat pump is a ductless minisplit: 0.74  If installed heat pump is a ducted ASHP: 0.34 | N/A | [521] |
| kWhc,b | Baseline cooling electrical consumption | Look up in Table 3‑113 | kWh/yr |  |
| kWhh,b | Baseline heating electrical consumption | Look up in Table 3‑113 | kWh/yr |  |
| kWhc,q | Energy efficient cooling electrical consumption | Look up in Table 3‑114 | kWh/yr |  |
| kWhh,q | Energy efficient heating electrical consumption | Look up in Table 3‑114 | kWh/yr |  |
| kWhsupplement | Energy efficient heating electrical consumption of supplemental heating system | Calculated | kWh/yr |  |
| Thermsb | Baseline fuel consumption | Look up in Table 3‑115 | Therms/yr |  |
| Thermsq | Energy efficient fuel consumption | Calculated | Therms/yr |  |
| Thermsq,ff | Fuel consumption of new efficient fuel equipment for partial displacement applications where a new supplemental fossil fuel heating system is installed | Calculated | Therms/yr |  |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [512] |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [512] |
| COPb | Coefficient of performance of the baseline unit at 47F | Look up in Appendix E: Code-Compliant Efficiencies | N/A | [509][511] |
| 1,000 | Conversion from W to kW | 1,000 | w/kW |  |
| 3.412 | Conversion factor from kWh to kBtu | 3.412 | kBtu/kWh |  |
| 1.4 | Conversion from therms to gallons | 1.4 | Therms/gal | 0 |
| 0.916 | Conversion from therms to gallons | 0.916 | Therms/gal | 0 |
| CF | Cooling coincidence factor | Look up in Table 3‑120 | N/A | [513] |
| PDF | Gas peak day factor | Look up in Table 3‑120 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [514] |
| RUL | Remaining useful life | See Measure Life Section | Years |  |

Table 3‑119 Partial Displacement Factors at Different Switchover Points[[115]](#footnote-117)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NJ Climate Region | Switchover Point | | | | | |
| **15°F** | **25°F** | **30°F** | **35°F (default)** | **40°F** | **45°F** |
| Northern | 0.95 | 0.78 | 0.68 | 0.43 | 0.29 | 0.17 |
| Southern | 0.99 | 0.82 | 0.71 | 0.43 | 0.29 | 0.19 |
| Coastal | 0.98 | 0.91 | 0.85 | 0.64 | 0.46 | 0.30 |
| Central | 0.99 | 0.83 | 0.74 | 0.47 | 0.31 | 0.19 |
| Pine Barrens | 1.00 | 0.86 | 0.76 | 0.46 | 0.31 | 0.19 |
| **Statewide Average** | **0.98** | **0.84** | **0.75** | **0.48** | **0.33** | **0.20** |

Use switchover point of 35°F unless alternative site-specific switchover point is known and supported with documentation such as a photo of programmed controls.

Peak Factors

Table 3‑120 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.5 | [513] |
| 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 3‑121 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Central A/C | 15 | 5 | [514] |
| Air source heat pump | 15 | 5 | [514] |
| Mini split heat pump | 15 | 5 | [514] |
| PTAC/PTHP | 15 | 5 | [514] |
| Room air conditioner | 12 | 4 | [514] |
| Fossil fuel furnace/boiler | 20 | 6.7 | [514] |
| Electric resistance/electric furnace | 20 | 6.7 | [514] |

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8. Oak Ridge National Laboratory*, Fuel Conversions Needed in the Weatherization Assistant*, <https://weatherization.ornl.gov/wp-content/uploads/2018/05/FuelConversions.pdf>
9. 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.
10. Determined by calculating the percentage of the heating degree hours (using 65°F balance point) exceeding the switchover point, which represents the proportion of the heating load presumed to be met by the heat pump. Metered data from New York shows that customers typically switch from heat pump to supplemental heating at around 35°F.
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### 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 | May 2024 |
| Changes Since Last Version |  |

Description

This prescriptive measure targets the use of water-to-air ground loop heat pumps, water-to-air groundwater heat pumps, brine-to-air ground loop heat pumps, brine-to-air groundwater 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.

This measure is limited to single-zone equipment; complex built-up systems should follow custom analysis. This measure requires that:

* The heat pump system will be installed in lost opportunity projects *or* in retrofit/early retirement projects in buildings with viable existing ductwork.
* The heat pump system will be the sole source of heating and cooling in the space; it will not be installed in association with another non-electric source of auxiliary heat.

Baseline Case

For whole building new construction and time of sale applications, the baseline equipment is a unitary packaged or split-system air source heat pump (or other 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. 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.

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 water-to-air groundwater loop water-to-air ground loop, brine-to-air groundwater loop, or brine-to-air ground loop heat pump that meets or exceeds code requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

Calculate kWhc,b, kWhh,b, and kWhp,b using the algorithms in Table 3‑122 for the appropriate baseline equipment type.

Calculate kWhc,q, kWhh,q, and kWhp,q using the algorithms in Table 3‑123 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 cooling output of the installed unit (Qc) and the heating output of the installed unit (Qh) are calculated as follows.

Note: 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 a default value of 0.8.

Table 3‑122 Baseline Energy Consumption Equations

|  |  |  |  |
| --- | --- | --- | --- |
| Baseline Equipment | Baseline Cooling kWh (kWhc,b) | Baseline Heating kWh (kWhh,b) | Auxiliary Energy Use kWh (kWhau,b)[[116]](#footnote-118) |
| Air Source Heat Pump (< 65 kBtu/h) |  |  | N/A |
| Air Source Air Conditioner (< 65 kBtu/h) |  | N/A | N/A |
| Air Source Heat Pump (≥ 65 kBtu/h) |  |  | N/A |
| Air Source Air Conditioner (≥ 65 kBtu/h) |  | N/A | N/A |
| PTAC with electric resistance heat |  |  | N/A |
| PTHP |  |  | N/A |
| Ground Source Heat Pump (< 65 kBtu/h) |  |  |  |
| GSHP (Cooling Capacity > 65 kBtu/h) |  |  |  |
| Electric Resistance/electric furnace heating | N/A |  | N/A |
| Room Air Conditioner |  | N/A | N/A |
| Fossil Fuel Furnace[[117]](#footnote-119) | N/A | N/A |  |

Table 3‑123 Energy Efficient Energy Consumption Equations

|  |  |  |
| --- | --- | --- |
| Efficient Cooling kWh  (kWhc,q) | Efficient Heating kWh  (kWhh,q) | Efficient Circulating Pump kWh  (kWhp,q) |
|  |  |  |

Calculate seasonal efficiencies as follows:

If heat pump is part-load capable:

If heat pump is not part-load capable:

Annual Fuel Savings

Where,

*(If the unit uses a furnace backup, use equation from Table 3‑124)*

Table 3‑124 Baseline Fuel Consumption

|  |  |
| --- | --- |
| Baseline Equipment | Baseline fuel consumption (Thermsb) |
| Fossil fuel furnace |  |
| Electric heating (heat pump, electric resistance) | 0 |

To calculate savings in gallons of delivered fuel, use Table 3‑125

Table 3‑125 Fuel Savings in Gallons

|  |  |
| --- | --- |
| Delivered Fuel | Fuel savings (gallons) |
| Oil |  |
| Propane |  |

Peak Demand Savings

Where,

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑126 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔGalOil | Oil savings | Calculated | Gallons |  |
| ΔGalPropane | Propane savings | Calculated | Gallons |  |
| kWhb | Baseline electrical consumption | Calculated | kWh/yr |  |
| kWhq | Energy efficient electrical consumption | Calculated | kWh/yr |  |
| Qc | Cooling output of qualifying unit | Calculated | Btu |  |
| Qh | Heating output of qualifying unit | Calculated | Btu |  |
| Capc | Cooling capacity of qualifying unit | Site-specific | Btu/hr |  |
| Caph | Heating capacity of qualifying unit | Site-specific | Btu/hr |  |
| Capfurnace | Heating capacity of pre-existing furnace (MBH) | Site-specific | MBH |  |
| Ffull | Seasonal weighting factor for full load efficiency | 0.25 | N/A | [524] |
| EERseason,q | Adjusted EER of qualifying unit | Calculated | Btu/W-h |  |
| EERfull,q | Full load EER of qualifying unit | Site-specific | Btu/W-h |  |
| Fpump,full | Factor to adjust the full load efficiency to account for additional pumping power used by the system | 0.90 | N/A | [524] |
| Fpart | Seasonal weighting factor for part load efficiency | 0.75 | N/A | [524] |
| EERpart,q | Part load EER of qualifying unit (if part load capable), per manufacturer literature or AHRI certification | Site-specific | Btu/W-h |  |
| Fpump,part | Factor to adjust the part load efficiency to account for additional pumping power used by the system | 0.84 | N/A | [524] |
| COPseason,q | Adjusted coefficient of performance of the qualifying unit | Calculated | N/A |  |
| COPfull,q | Full load coefficient of performance of the qualifying unit, per manufacturer literature or AHRI certification | Site-specific | N/A |  |
| COPpart,q | Part load coefficient of performance of the qualifying unit (if part-load capable), per manufacturer literature or AHRI certification | Site-specific | N/A |  |
| HPq | Horsepower of qualifying ground/groundwater loop circulating pump motor | Site-specific | HP |  |
| HPb | Horsepower of base case ground/groundwater loop circulating pump motor | Site-specific, if unknown use HPq | HP |  |
| SEER2b | SEER2 of baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [529][530] |
| IEERb | IEER of baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [529][530] |
| EER2b | EER2 of baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | Btu/W-h | [529][530] |
| HSPF2b | Heating seasonal performance factor of the baseline unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies. | Btu/W-h | [529][530] |
| CEERb | Combined Energy Efficiency Ratio of baseline room air conditioner[[118]](#footnote-120) | Use federal standard values in Appendix E, if unknown, use 11.0 | Btu/W-h | See footnote |
| Effmotor,b | Efficiency of base case ground/groundwater loop circulating pump motor | Site-specific, if unknown look up in Table 3‑127 | N/A | [531] |
| Effmotor,q | Efficiency of qualifying ground/groundwater loop circulating pump motor | Site-specific, if unknown look up in Table 3‑127 | N/A | [531] |
| Effb,fuel | Efficiency of baseline of furnace | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | N/A | [529][530] |
| OSF | Oversize derating factor | Site-specific, if unknown use 0.8 | N/A |  |
| kWhc,b | Baseline cooling electrical consumption | Look up in Table 3‑122 | kWh/yr |  |
| kWhh,b | Baseline heating electrical consumption | Look up in Table 3‑122 | kWh/yr |  |
| kWhp,b | Baseline pump electrical consumption | Look up in Table 3‑122 | kWh/yr |  |
| kWhc,q | Energy efficient cooling electrical consumption | Look up in Table 3‑123 | kWh/yr |  |
| kWhh,q | Energy efficient heating electrical consumption | Look up in Table 3‑123 | kWh/yr |  |
| kWhp,q | Energy efficient ground/groundwater loop circulating pump electrical consumption | Look up in Table 3‑123 | kWh/yr |  |
| Thermsb | Baseline fuel consumption | Look up in Table 3‑124 | Therms/yr |  |
| Thermsq | Energy efficient fuel consumption | 0 | Therms/yr |  |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [522] |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [522] |
| COPb | Coefficient of performance of the baseline unit | Look up in Appendix E: Code-Compliant Efficiencies | N/A | [529][530] |
| 1.09 | Correction for 9% increase in EER as the entering fluid temperature decreases from 77°F to 68°F | 1.09 | N/A | [524] |
| 1.08 | Correction for 8% increase in COP as entering fluid temperature increases from 32°F to 40°F | 1.08 | N/A | [524] |
| 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 |  |
| 1.4 | Conversion from therms to gallons | 1.4 | Therms/gal |  |
| 0.916 | Conversion from therms to gallons | 0.916 | Therms/gal |  |
| LF | Load factor of pump motor | 0.75 | N/A | [525] |
| DSFVFD | Demand savings factor to account for variable speed pumping in qualifying unit | If variable speed pump: 0.210  If constant speed: 1.0 |  | See section 3.5.17 |
| FLHpump | Annual full-load hours of ground/groundwater loop circulating pump motor, approximated as EFLHc + EFLHh | Look up in Appendix D: HVAC Fan and Pump Operating Hours | Hours |  |
| CFc | Cooling coincidence factor | Look up in Table 3‑128 | N/A |  |
| CFpump | Pump coincidence factor | Look up in Table 3‑128 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑128 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life | See Measure Life Section | Years |  |

Table 3‑127 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 3‑128 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Cooling coincidence factor (CFc) | 0.5 | [526] |
| Pump coincidence factor (CFpump) | If unit runs 24/7/365, CF=1.0, else use 0.5 | [526] |
| 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 3‑129 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Water source Pump | 15 | 5 | [528] |
| Ground source heat pump | 25 | 8.33 | [528] |
| Central A/C | 15 | 5 | [528] |
| Air source heat pump | 15 | 5 | [528] |
| PTAC/PTHP | 15 | 5 | [528] |
| Room air conditioner | 12 | 4 | [528] |
| Fossil fuel furnace | 20 | 6.7 | [528] |
| Electric resistance/electric furnace | 20 | 6.7 | [528] |

References

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### Gas Heat Pumps

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | NC/TOS/EREP |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | March 2024 |
| Changes Since Last Version |  |

Description

This measure targets the use of gas heat pumps in commercial applications as further described below. Gas-fired heat pumps are a subset of heat pumps whose primary input drive energy is a gaseous fuel, instead of an electrically-driven compressor. This measure may apply to early replacement of an existing system, replacement on failure, or installation of a new unit in a new or existing commercial building for HVAC applications.

Baseline Case

For whole building new construction, the baseline equipment is a gas-fired hot water boiler, direct expansion cooling system, and a water heater all compliant with ASHRAE 90.1-2019 (see Appendix E: Code-Compliant Efficiencies).

For replacement of failed equipment, or end of useful life, the baseline is a minimally code compliant (ASHRAE 90.1-2019) 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 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 minimally code-compliant (ASHRAE 90.1-2019 or current code at end of RUL) version of the replaced equipment.

Efficient Case

A gas heat pump for space heating/cooling and domestic hot water heating that meets program eligibility requirements.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 1‑2 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔThermsSpace | Space Heating Savings | Calculated | Therms/yr |  |
| ΔThermsDHW | Domestic hot water savings | Calculated | Therms/yr |  |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | Lookup in Appendix C: Heating and Cooling EFLH | Hours | [512] |
| Caph | Heating capacity of qualifying unit | Site-specific | Btu/hr |  |
| Effb | Efficiency of baseline space heating unit | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies | N/A | [509][511] |
| Effq | Space heating efficiency of gas heat pump | Site-specific | N/A |  |
| Tout | Tank temperature | Site-specific, if unknown, use 125 | °F | [539] |
| Tin | Supply water temperature in water main[[119]](#footnote-121) | 60 | °F | [538] |
| GPD | Estimated annual hot water consumption | Site-specific , if unknown look up in Table 3-349 | Gal/day |  |
| 365 | Days per year | 365 | Day/yr |  |
| 8.33 | Specific weight capacity of water | 8.33 | lbs/gal |  |
| 1.0 | Specific heat of water | 1.0 | Btu/lb°F |  |
| 100,000 | Conversion from Btu to Therms | 100,000 | Btu/Therms |  |
| EEFb,DHW | Rated efficiency of baseline water heater | TOS/NC: Look up in Appendix E for current code-compliant efficiency EREP: Site-specific, if unknown use code efficiency in force when equipment was new. If vintage is unknown, look up in Appendix E Table 9-8 | N/A | [511] |
| EEFq,DHW | Rated efficiency of the commercial gas heat pump as certified expressed as Uniform Energy Factor (UEF) or Coefficient of Performance | Site-specific COP or calculate UEF with equations in Appendix E Table 9-7 | N/A | [511] |
| PDF | Gas peak day factor | Look up in Table 3‑120 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [514] |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Peak Factors

Table 3‑130 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) for the gsa heat pump is 15 years [1]. The remaining useful life (RUL) for existing equipment is limited to 1/3 of the effective useful life (EUL) of the equipment.

References

1. *2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12 Volume 2: Commerical and Industrial Measures* (September 2023), Pg 600, <https://icc.illinois.gov/api/web-management/documents/downloads/public/il-trm-12/IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf>
2. 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](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)
3. 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
4. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
5. 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>
6. 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>
7. 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.

### 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 |
| Changes Since Last Version |  |

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. [542]

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑131 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Capin | Input capacity of qualifying unit | Site-specific | kBtu/hr |  |
| HDD55 | Heating degree days: number of degrees the average daily temperature is below 55°F | Look up in Table 3‑132 | °F-day | [540] |
| HDD65 | Heating degree days: number of degrees the average daily temperature is below 65°F | Look up in Table 3‑132 | °F-day | [540] |
| Tdesign | Equipment design temperature | Look up in Table 3‑132 | °F | [543] |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | See Appendix C: Heating and Cooling EFLH | hour/yr | [541] |
| 100 | Conversion from kBtu to therms | 100 | kBtu/therms |  |
| CF | Electric coincidence factor | Look up in Table 3‑133 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑133 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 3‑132 Heating Degree Days and Equipment Design Temperature

|  |  |  |  |
| --- | --- | --- | --- |
| Climate Zone | HDD65 | HDD55 | Tdesign |
| 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 | 5,553 | 3,288 | 11.1 |

Peak Factors

Table 3‑133 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 3‑134 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Infrared Heater | 17 | 5.7 | [545] |

References

1. 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.
2. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
3. 2012 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 16, Infrared Radiant Heating.
4. ASHRAE Fundamentals 2021, Chapter 14 Climactic Design Conditions, [https://handbook.ashrae.org/Handbook.aspx#](https://handbook.ashrae.org/Handbook.aspx" \t "_blank" \o "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.
5. 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
6. 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/

### Gas Forced Air and Hydronic Heating

|  |  |
| --- | --- |
| 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 |
| Changes Since Last Version | * Renamed measure to “gas forced air and hydronic heating” * Updated algorithm to account for equipment oversizing |

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

Where,

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑135 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLifetime | Lifetime fuel savings | Calculated | Therms |  |
| Capout | Output capacity of qualifying unit | Site-specific | Btu/hr |  |
| Effq | Equipment Proposed Efficiency | Site-specific | Varies |  |
| HSPFb | Heating seasonal performance factor of baseline electric unit | 3.412 |  |  |
| EFLHh | 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 | [546] |
| Effb | Gas equipment baseline efficiency | Look up in Table 3‑136 | Varies | [547][548] |
| EffAF | Equipment baseline efficiency ISP adjustment Factor | 1.15 (New Construction furnaces only)  1.0 (all others) | N/A | [549] |
| Fos | Factor to account for baseline efficiency degradation when equipment is oversized more than the standard assumption | 0.9 | N/A | [553] |
| 1,000 | Conversion factor | 1,000 | Watts/kW |  |
| 100,000 | Conversion factor | 100,000 | Btu/Therm |  |
| CF | Electric coincidence factor | Look up in Table 3‑137 Peak Factors | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑137 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 3‑136 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 |
| 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 3‑137 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 3‑138 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Furnace | 20 | 6.67 | [550] |
| Unit Heater | 18 | 6 | [551] |
| Boiler | 20 | 6.67 | [550] |
| Electric Resistance Heating | 20 | 6.67 | [552] |

References

1. Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
2. *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
3. *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>
4. *New Jersey Commercial New Construction Industry Standard Practice Analysis.* Prepared for Rutgers University by DNV. June 2022.
5. California Database of Energy Efficient Resources (DEER) <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>
6. Ecotope, *Natural Gas Efficiency and Conservation Measure Resource Assessment*, 2003, section 5.2.3, <https://ecotope-publications-database.ecotope.com/2003_007_NaturalGasEfficiency.pdf>
7. *Energy Saver 101: Everything you need to know about Home Heating* <https://www.energy.gov/sites/prod/files/2014/01/f6/homeHeating.pdf>
8. Placeholder assumption based on NREL simulation model relationships between efficiency and part load ratio

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑139 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| SF | Savings Factor: estimated percent reduction in heating load due to controls being installed. | Lookup in Table 3‑140 | % | [554] [555] |
| EFLHh | Equivalent full load hours for heating | Look up in Appendix C: | hrs | [556] |
| Capin | 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 3‑140 Savings Percentage

|  |  |  |
| --- | --- | --- |
| Control Type | Savings | Ref |
| Boiler Reset | 5.0% | [554] |
| Boiler Cut-Out | 1.7% | [555] |
| Boiler Reset & Cut-Out | 5% |  |

Peak Factors

Table 3‑141 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 3‑142 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Boiler Controls | Smaller of: boiler RUL or 7.33 | N/A |  |
| Boiler (steel water-tube) | 22 | 7.33 | [557] |
| Boiler (steel fire-tube) | 25 | 8.33 | [557] |
| Boiler (cast iron) | 35 | 11.67 | [557] |

References

1. 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>
2. 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
3. Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.
4. ASHRAE Handbook 2019, HVAC Applications. Chapter 38 *Owning and Operating Costs*, Table 4.

### 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 [558].

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 [560].

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

Annual Fuel Savings

Economizer for Boilers Serving HVAC Loads:

Where,

Economizer for Boilers Serving Process Loads:

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑143 Calculation Parameters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Description | | Value | Units | | Ref | |
| ΔTherms | | Annual fuel savings | | Calculated | Therms/yr | |  |
| ΔThermsPeak | | Daily peak fuel savings | | Calculated | Therms/day | |  |
| ΔThermsLife | | Lifetime fuel savings | | Calculated | Therms | |  |
| ESF | | Energy Savings Factor | | Calculated | N/A | | [561] |
| Capin | | Input capacity of qualifying unit | | Site-specific | kBtu/hr | |  |
| Tb | | 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[[120]](#footnote-122) | °F | | [562] |
| Tq | | Energy efficient full-fire boiler flue gas temperature as it exits the stack | | Site-specific. If unknown, look up in Table 3‑144 | °F | | [559] |
| 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 | | [561] |
| EFLHh | | Equivalent Full Load Hours of operation for the average unit during the heating season | | Look up in Appendix C: | Hrs/yr | | [562] |
| 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 | | [565] |
| UF | | Utilization factor | | 0.419 | N/A | | [565] |
| PDF | | Gas peak day savings factor | | Look up in Table 3‑145 | N/A | |  |
| EUL | | Effective useful life | | See Measure Life Section | Years | |  |

Table 3‑144 Energy Efficient Boiler Flue Gas Temperature

|  |  |  |
| --- | --- | --- |
| Equipment Type | Conventional Economizer[[121]](#footnote-123),[[122]](#footnote-124) | Condensing Economizer[[123]](#footnote-125),[[124]](#footnote-126) |
| Hot Water Boiler | 335 °F | 247.5 °F |
| Steam Boiler | 375 °F | 287.5 °F |

Peak Factors

Table 3‑145 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 3‑146 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Boiler | 20 | 6.67 | [557] |

References

1. 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>
2. 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>
3. 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>
4. 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>
5. 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>
6. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
7. California Database of Energy Efficient Resources (DEER). <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>
8. *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>

### Gas Chillers

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC |
| Baseline | Code |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑147 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermswinter | Annual winter fuel savings | Calculated | Therms/yr |  |
| Thermssummer | Annual summer fuel usage | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| IR | Input rating | Site-specific | MMBtu/hr |  |
| Cap | Cooling capacity of gas chiller | Site-specific | MMBtu/hr |  |
| COPb | Coefficient of performance of baseline unit | Site-specific, if unknown look up in Table 3‑148 | N/A | [567] |
| COPq | Coefficient of performance of energy efficient unit | Site-specific | N/A |  |
| EFLHc | Equivalent full load hours, cooling | Look up in Appendix C: |  |  |
| CF | Electric coincidence factor | Look up in Table 3‑149 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑149 | N/A |  |
| 10 | Unit conversion, Therms/MMBtu | 10 | Therms/MMBtu |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑148 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 3‑149 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 [566].

References

1. DEER 2014
2. ASHRAE 90.1 2019 Table 6.8.1-3

### Electric Chillers

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/EREP |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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.

Early replacement: Use dual baseline. Baseline is site-specific pre-existing equipment for first baseline period. Baseline is chiller compliant with ASHRAE Std. 90.1-2019 for second baseline period.

Efficient Case

Chiller with an efficiency greater than code.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑150 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Tons/Unit | Rated capacity of cooling equipment. | Site-specific | Tons |  |
| IPLVb | Integrated Part Load Value of baseline equipment, the efficiency of the chiller under partial-load conditions | TOS/NC: Look up in Table 3‑151  EREP: Site-specific. If unknown, look up in Table 3‑151 | kW/ton | [569] |
| IPLVq | Integrated Part Load Value of qualifying unit, the efficiency of the chiller under partial-load conditions | Site-specific | kW/ton |  |
| FLVb | Full Load Value of baseline equipment, the efficiency of the chiller under full-load conditions | TOS/NC: Look up in Table 3‑151  EREP: Site-specific. If unknown, look up in Table 3‑151 | kW/ton | [569] |
| FLVq | Full Load Value of qualifying equipment, the efficiency of the chiller under full-load conditions | Site-specific | kW/ton |  |
| EFLHc | Equivalent Full Load Cooling Hours | Look up in Appendix C: Heating and Cooling EFLH | hr | [570] |
| CF | Electric coincidence factor | Table 3‑152 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑151 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 3‑152 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.67 | [568] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 23 years. [571]

References

1. 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.
2. 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>
3. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.
4. 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).

### 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 (QOA) 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 QOA 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 3‑154 through Table 3‑166.

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 QOA 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 3‑155 through Table 3‑157.
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 3‑158 through Table 3‑160.
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 3‑161 through Table 3‑163.
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 3‑164 through Table 3‑166.

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑153 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| tfan | Supply air fan runtime | Use one of the 4 scenarios in the description above | Hours |  |
| CFM | Supply fan airflow | Site-specific | ft3/min |  |
| ΔP | Additional pressure drop of the condensing heat exchanger of warm air furnace section | -0.15 | Inch w.g. | [572] |
| Efffan,motor | Combined fan and motor efficiency | 0.6 | N/A | [572] |
| 8,520[[125]](#footnote-127) | Conversion factor | 8,520 | N/A |  |
| QOA | Annual outside air heating load per cfm of OA | Look up in Table 3‑155 through Table 3‑166 | Btu/cfm | [572] |
| Effb | Baseline non condensing efficiency | Look up in Table 3‑154 | N/A | [573] |
| Effq | Efficient condensing efficiency | Site-specific. Use the same efficiency metric as Effb | N/A |  |
| 100,000 | Conversion from Btu to therm | 100,000 | Btu/therm |  |
| CF | Electric coincidence factor | Look up in Table 3‑167 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑167 | N/A |  |
| EUL | Effective useful life | See  Measure Life Section | Years |  |
| RUL | Remaining useful life of existing unit | See  Measure Life Section | Years |  |

Table 3‑154 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 3‑155 8760 Annual Operation Scenario for HDD45

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 8760 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑156 8760 Hour Annual Operation Scenario for HDD55

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 8760 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑157 8760 Hour Annual Operation Scenario for HDD65

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 8760 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑158 7300 Annual Operation Scenario for HDD45

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 7300 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑159 7300 Annual Operation Scenario for HDD55

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 7300 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑160 7300 Annual Operation Scenario for HDD65

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 7300 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑161 5266 Annual Operation Scenario for HDD45

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 5266 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑162 5266 Annual Operation Scenario for HDD55

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 5266 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑163 5266 Annual Operation Scenario for HDD65

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 5266 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑164 3911 Annual Operation Scenario for HDD45

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 3911 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑165 3911 Annual Operation Scenario for HDD55

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 3911 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑166 3911 Annual Operation Scenario for HDD65

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| tfan = 3911 Hours | Qoa (Annual Btu/cfm) | | | |
| **At Supply Air Temperature Of** | | | |
| **Climate Zone -** | **75oF** | **85oF** | **95oF** | **105oF** |
| **Weather Station/City** |
| 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 3‑167 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1 | [572] |
| 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 3‑168 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Make-up Air Unit | 15 | 5 | [574] |

References

1. *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>.
2. 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>.
3. DEER 2014 EUL <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>.

### 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

Cooling energy savings:

For ERVs:

For HRVs:

Heating energy savings (both ERVs and HRVs):

Fan energy savings:

Calculate baseline and qualifying fan kW as follows.[[126]](#footnote-128) Use first equation if values are known, otherwise use second equation:

Annual Fuel Savings

Summer Peak Demand Savings

For ERVs:

For HRVs:

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑169 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔthermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔthermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhc | Annual electric energy savings during cooling season | Calculated | kWh |  |
| ΔkWhh | Annual electric energy savings during heating season | Calculated | kWh |  |
| ΔkWhfan | Annual electric energy savings due to fan operation | Calculated | kWh |  |
| kWfan,b | Total electric power of baseline supply and exhaust fans | Calculated | kW |  |
| kWfan,q | Total electric power of efficient supply and exhaust fans | Calculated | kW |  |
| CFM | Volume of supply air | Site-specific | Ft3/min |  |
| Effhx,total | Total effectiveness of heat exchanger per rating in accordance with AHRI Standard 1060 | Site-specific | N/A | [575] |
| Effhx,sens | Sensible effectiveness of heat exchanger per rating in accordance with AHRI Standard | Site-specific | N/A | [575] |
| Effelec,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 | [576] |
| EER2 | Energy efficiency ratio of electric cooling equipment[[127]](#footnote-129) | 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[[128]](#footnote-130) | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size | Btu/watt-hour |  |
| Efffuel,h | Efficiency of fossil fuel heating equipment (AFUE, Et or Ec) | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size | N/A |  |
| Tindoor,h | Indoor heating setpoint temperature | Site-specific, if unknown use 70°F | °F |  |
| Tindoor,c | Indoor cooling setpoint temperature | Site-specific, if unknown use 70°F | °F |  |
| Hindoor | Enthalpy of indoor air | Look up in Table 3‑170 based on Tindoor | Btu/lb |  |
| Efffan,mech | Mechanical efficiency of ERV fans | Site-specific, if unknown use 0.67 | N/A | [577] |
| Efffan,motor | Efficiency of ERV fan motors | Site-specific, if unknown use 0.7[[129]](#footnote-131) | N/A | [578] |
| ΔP | Pressure drop at nominal airflow in the ERV as rated in accordance with AHRI Standard 1060 | Site-specific | Inches of H2O |  |
| HP | Total fan horsepower | Site-specific | HP |  |
| LF | Load factor | Site-specific, if unknown use 0.92 | N/A | [583] |
| hrsc | Operating hours in the cooling season | Look up in Table 3‑171 | hrs | [581] |
| hrsh | Operating hours in the heating season | Look up in Table 3‑171 | hrs | [581] |
| Houtdoor,c | Enthalpy of outside air during cooling | Look up in  Table 3‑172 | Btu/lb | [582] |
| Houtdoor,h | Enthalpy of outside air during heating | Look up in  Table 3‑172 | Btu/lb | [582] |
| Toutdoor,c | Avg. outdoor temperature during cooling season. | Look up in  Table 3‑172 | °F | [582] |
| Toutdoor,h | Avg. outdoor temperature during heating season | Look up in  Table 3‑172 | °F | [582] |
| Toutdoor,c,peak | Peak outdoor temperature during cooling season | Look up in Table 3‑173 | °F | [584] |
| Houtdoor,c,peak | Peak Enthalpy of outdoor air during cooling season | Look up in Table 3‑173 | °F | [584] |
| FElecHeat | Electric heating factor, to account for presence of electric heat | Use 1 if electric heat, otherwise use 0 | N/A |  |
| FFuelHeat | 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/ft3.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/ft2)/ inH2O |  |
| CF | Electric coincidence factor | Look up in Table 3‑174 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑174 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑170 Indoor Enthalpy

|  |  |
| --- | --- |
| Temperature, Tindoor (°F) | Enthalpy, Hindoor 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 |
| 73 | 27.0 |
| 74 | 27.5 |
| 75 | 28.1 |
| 76 | 28.7 |
| 77 | 29.3 |
| 78 | 29.9 |

Table 3‑171 Heating and Cooling Hours[[130]](#footnote-132)

|  |  |  |
| --- | --- | --- |
| NJ Climate Region | Heating Hours, hrsh | Cooling Hours, hrsc |
| 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 3‑172 Outdoor Air Temperature and Enthalpy[[131]](#footnote-133)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NJ Climate Region | Relative Humidity[[132]](#footnote-134) (%) | Avg. outdoor temperature[[133]](#footnote-135) during cooling season, Toutdoor,c (°F) | Avg. outdoor temperature134 during heating season, Toutdoor,h (°F) | Avg enthalpy[[134]](#footnote-136) of outdoor air at duing cooling season, Houtdoor,c (Btu/lb) | Avg enthalpy135 of outdoor air at duing cooling season, Houtdoor,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 |
| 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 3‑173 Peak Outdoor Air Temperature and Enthalpy

|  |  |  |
| --- | --- | --- |
| NJ Climate Region | Peak outdoor temperature during cooling season, Toutdoor,c,peak (°F) | Peak Enthalpy of outdoor air at duing cooling season, Houtdoor,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 3‑174 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [579] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 14 years[580].

References

1. *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
2. 10 CFR 430.32 (c)(1) , December 2022. <https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430>
3. 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>
4. 10 CFR 431.446 , December 2022. <https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431>
5. 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.
6. 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>
7. ONJSC: Monthly/Annual Temperature Normals (1991-2020), December 2022 <http://climate.rutgers.edu/stateclim_v1/norms/monthly/index.html>.
8. NSRDB, TMY3 data, December 2022. <https://nsrdb.nrel.gov/data-sets/tmy>
9. *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
10. ASHRAE Fundamentals 2021 - Chapter 14 Climactic Design Conditions - [https://handbook.ashrae.org/Handbook.aspx#](https://handbook.ashrae.org/Handbook.aspx)

### Demand Controlled Ventilation

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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 CO2, and the CO2 concentration in the air increases in proportion to the number of occupants. The CO2 concentration provides a good indicator of overall air quality. Demand control ventilation (DCV) systems monitor indoor air CO2 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 [585].

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑175 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| A | Total area square footage of the conditioned space impacted by the measure | Site-specific | Ft2 |  |
| SFElecCool | DCV energy savings factor for cooling | Look up in Table 3‑176 | kWh/1,000 ft2 | [585] |
| SFElecHeat | DCV energy savings factor for electric heating | Look up in Table 3‑177, Table 3‑178 | kWh/1,000 ft2 | [585] |
| FelecHeat | Electric heating factor, used to account for the presence or absence of an electric heating system | 1 (if electric heat)  0 (otherwise) | N/A |  |
| SFFuel | DCV fuel savings factor for heating | Look up in Table 3‑179 | Therms/1,000 ft2 | [585] |
| FFuelHeat | 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 3‑180 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑180 | N/A |  |
| 10 | Unit conversion, Therm/MMBtu | 10 | Therm/MMBtu |  |
| EUL | Effective useful life | See Measure Life Section | Years | [586] |

Table 3‑176 Energy Savings Factor for Cooling (kWh/1,000 ft2)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Building Type | North | Coastal | Central | Pine Barrens | Southwest | Statewide Average[[135]](#footnote-137) |
| 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 |
| 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 3‑177 Electric Heating Savings with Heat Pump (kWh/1,000 ft2)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Building Type | North | Coastal | Central | Pine Barrens | Southwest | Statewide Average136 |
| 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 3‑178 Electric Heating Savings with Electrical Resistance (kWh/1,000 ft2)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 3‑179 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 |
| 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 3‑180 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 [586]. If applied to a packaged HVAC system, the RUL of the host equipment is 5 years.

References

1. *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>
2. ERS (2005). *Measure Life Study prepared for The Massachusetts Joint Utilities*.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑181 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | 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 | [590] |
| 1,400 | Estimation of CFM delivered per kW consumed from both exhaust and make-up air fan motor | 1,400 | Cfm/kW | [588] |
| Hours | Hours per day hood is operated | Site-specific, if actual hours are unknown assume 5 hours per meal served. | hrs | [590] |
| Days | Number of days kitchen is in operation per week | Site-specific | Days |  |
| Weeks | Number of weeks kitchen is in operation | Site-specific, if actual weeks are unknown assume 50 weeks per year. | Weeks | [590] |
| %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 | [590] |
| PLR | Part load ratio for a given flow fraction range | Look up Table 3‑182 | N/A | [590] |
|  | Cooling savings factor | 0.471 | N/A | [589] |
|  | 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 | [590] |
|  | Heating savings factor | Lookup Table 3‑183. If percent of make-up air from dining room is unknown, assume 30% from dining room | MMBtu/kWh | [589] [590] |
| CF | Electric coincidence factor | Look up in Table 3‑184 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑184 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑182 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 3‑183 Heating Savings Factor (SFHeat)

|  |  |  |
| --- | --- | --- |
| 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 |
| 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 3‑184 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. [587]

References

1. 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. Estimation of CFM delivered per kW consumed from both exhaust and make-up air fan motor. Derived from proprietary Navigant DCKW tool.
3. 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.
4. *Mid-Atlantic Technical Reference Manual: Version 10* (May 2020), <https://neep.org/mid-atlantic-technical-reference-manual-trm-v10>, Pg 404

### Destratification Fan

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | NC/RF |
| Baseline | ISP/Existing |
| End Use Subcategory | HVAC |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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 ofthe fans. Other applications require custom analysis.
* Installation must follow manufacturer recommendations sufficient to effectively destratify the entirespace.
* Measure does not currently support facilities with night setbacks on heating equipment. Custom analysisis needed in this case.
* Certain heating systems may not be a good fit for destratification fans, such as locations with: highvelocity vertical throw unit heaters, radiant heaters, and centralized forced air systems. In these cases,measured evidence of stratification shouldbe 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

In all cases:

If building is electricially heated:

Where,

If building is not electricially heated:

Annual Fuel Savings

Annual Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑185 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhh | Savings due to reduced heat loss from air destratification (if building is electrically heated) | Calculated | kWh |  |
| kWhfan | Annual electric consumption of fan | Calculated | kWh |  |
| ΔQr | Heat loss reduction through the roof due to the destratification fan | Calculated | Btu/hr |  |
| ΔQw | Heat loss reduction through the exterior walls due to destratification fan | Calculated | Btu/hr |  |
| Tw,s | Average indoor air temperature for wall heat loss, stratified case | Calculated | °F | [591] |
| Tw,d | Average indoor air temperature for wall heat loss, destratified case | Calculated | °F | [591] |
| Wfan | Rated fan wattage | Site-specific | W |  |
| hrfan | Annual fan operating hours | Site-specific, if unknown look up in Appendix D: HVAC Fan and Pump Operating Hours |  |  |
| Tr,s | Indoor temperature at roof deck, stratified case | Site-specific or calculated | °F | [591] |
| Tr,d | Indoor temperature at roof deck, destratified case | Site-specific or calculated | °F | [591] |
| COP | Heating efficiency of electric heating system | Site-specific, calculate if needed:  COP = HSPF/3.413 | N/A | [591] |
| Eff | Fuel heating system efficiency | Site-specific | N/A | [591] |
| Rr | Overall thermal resistance through the roof | Site-specific, if unknown look up in  Table 3‑186 | Hr\*ft2\*F/Btu | [591] |
| Ar | Roof area | Site-specific | Ft2 | [591] |
| Rw | Overall thermal resistance through the exterior walls | Site-specific, if unknown look up in  Table 3‑186 | Hr\*ft2\*F/Btu | [591] |
| Aw | Area of exterior walls | Site-specific | Ft2 | [591] |
| hr | Ceiling height/roof deck | Site-specific | ft | [591] |
| Tstat | Temperature set point at the thermostat | Site-specific | °F | [591] |
| hstat | Vertical distance between the floor and the thermostat | Site-specific, if unknown use 5 | Ft | [591] |
| ms | Estimated heat gain per foot elevation, stratified case | 0.8 | F/ft | [591] |
| Hrsheat | Total annual heating hours | Site-specific, if unknown look up in Table 3‑187 | Hours | [591] |
| 29.31 | Conversion factor | 29.31 | kWh/therm | [591] |
| 100,000 | Conversion factor | 100,000 | Btu/therm | [591] |
| PDF | Peak day factor | Look up in Table 3‑152 | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years | [591] |

Table 3‑186 Thermal Resistance Factors

|  |  |  |
| --- | --- | --- |
| Location | Retrofit | New Construction |
| Roof (Rr) | 15.0 | 30.0 |
| Wall (Rw) | 6.5 | 13.0 |

Table 3‑187 Annual Heating Hours by Climate Zone

|  |  |
| --- | --- |
| **Climate Zone** | **Annual Heating Hours[[136]](#footnote-138)** |
| Northern | 4,970 |
| Southwest | 4,896 |
| Coastal | 4,981 |
| Central | 4,969 |
| Pine Barrens | 4,899 |
| **Statewide Average** | **4,955** |

Peak Factors

Table 3‑188 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | N/A: No peak demand savings because no savings from cooling | [591] |
| 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 [591].

References

1. 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>

### Duct Sealing and Duct Insulation

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Category | HVAC |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑189 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhcooling | Annual electric energy savings, cooling | Calculated | kWh/yr |  |
| ΔkWhheating | Annual electric energy savings, heating | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Capcool | Capacity of air cooling system | Site-specific | ton |  |
| Capheat | Output capacity of air heating system | Site-specific | kBtu/hr |  |
| CFM25B | Standard duct leakage test result at 25 Pascal pressure differential of the duct system prior to sealing | Site-specific | CFM |  |
| CFM25Q | 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 2‑95 | Btu/W·hr | [127] |
| HSPF | Heating seasonal performance factor | Site-specific, if unknown look up in Table 2‑95 | Btu/W·hr | [127] |
| DEpre | Distribution efficiency before duct sealing and insulation | 0.89 | N/A | [594] |
| AFUE | Annual fuel utilization efficiency | Look up in  Table **2‑96**xx | N/A | [127] |
| EFLHcool | Cooling equivalent full load hours | See Appendix C | Hrs |  |
| EFLHheat | Heating equivalent full load hours | See Appendix C | Hrs |  |
| 400 | Rule of Thumb, CFM/ton | Site-specific, if unknown use 400 | CFM/ton |  |
|  | Cooling thermal regain factor based on duct location | Semi-conditioned space: 0.0  Unconditioned space or outdoors: 1.0 | N/A | [594] |
|  | Heating thermal regain factor based on duct location | Semi-conditioned space: 0.4  Unconditioned space or outdoors: 1.0 | N/A | [594] |
| 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 2‑97 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 2‑97 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑190 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 3‑191 AFUE Values

|  |  |
| --- | --- |
| Product Class | AFUE |
| Non-weatherized gas furnaces | 0.80 |
| Weatherized gas furnaces | 0.81 |

Peak Factors

Table 3‑192 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.69 | [594] |
| Natural gas peak day factor (PDF) | See Appendix H: Net-to-Gross Factors |  |

Measure Life

Table 3‑193 Measure Life

|  |  |  |
| --- | --- | --- |
| Equipment | EUL | Ref |
| Duct Sealing | 15 | [131] |

References

1. 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>
2. 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. Home Energy Services Impact Evaluation, prepared for the Massachusetts Residential Retrofit and Low Income Program Area Evaluation, Cadmus Group, Inc., August 2012.

### 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 [595].

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

For blower fans:

For circulator pumps:

If motor wattage is unknown, estimate as:

Annual Fuel Savings

Peak Demand Savings

Peak Daily Fuel Savings:

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑194 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhh | Annual electric heating savings | Calculated | kWh/yr |  |
| ΔkWhc | Annual electric cooling savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| Wb | Wattage of baseline motor | Site-specific, if unknown calculate from HP | Watts |  |
| Wq | Wattage of efficient motor | Site-specific | Watts |  |
| Effmotor | Motor efficiency | Site-specific, if unknown look up in Table 3‑195 | N/A | [598] |
| Hrsh | Motor operating hours, heating | Site-specific, if unknown see Appendix D: HVAC Fan and Pump Operating Hours | Hrs |  |
| Hrsc | Motor operating hours, cooling | Site-specific, if unknown see Appendix D: HVAC Fan and Pump Operating Hours | Hrs |  |
| ESFh | Energy savings factor, heating | 0.23 | N/A | [597] |
| ESFc | Energy savings factor, cooling | 0.38 |  | [597] |
| LF | Motor load factor | 0.9 | N/A | [597] |
| HVACe | HVAC interactivity factor, electric | See Appendix F: HVAC Interactivity Factors | N/A |  |
| HVACd | HVAC interactivity factor, demand | See Appendix F: HVAC Interactivity Factors | N/A |  |
| HVACff | HVAC interactivity factor, fossil fuel | See Appendix F: HVAC Interactivity Factors | N/A |  |
| CF | Coincidence factor | Look up in Table 3‑196 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑196 | 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 3‑195 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 3‑196 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [596] |
| 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

1. 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>
2. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential Multifamily, and Commercial/Industrial Measures. Version 6. April 16, 2018.
3. US DOE, *Evaluation of Retrofit Variable-Speed Furnace Fan Motors*, January 2014. <https://www.nrel.gov/docs/fy14osti/60760.pdf>
4. 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.

### Economizer Controls

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | NC/RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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

RF: The baseline condition is the site-specific HVAC unit with fixed outside air (no economizer). Use site-specific tonnage for calculation.

NC: New construction installations only eligible if economizer not required by code. The NC baseline is the site-specific and code-compliant HVAC unit with fixed outside air. Use site-specific tonnage for calculation.

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑197 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 3‑198 | Hrs/yr | [599] |
| CF | Electric coincidence factor | Look up in Table 3‑199 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑199 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑198 Economizer savings kWh per Cooling Ton

|  |  |
| --- | --- |
| Building Type | (kWh/ton)Econ |
| Assembly | 27 |
| Big Box Retail | 152 |
| Fast Food Restaurant | 39 |
| Full Service Sertaurant | 31 |
| Light Industrial | 25 |
| Elementary School | 42 |
| Small Office | 186 |
| Small Retail | 95 |
| Religious | 6 |
| Warehouse | 2 |
| Other | 61 |

Peak Factors

Table 3‑199 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 effective useful life (EUL) is 10 years [600].

References

1. *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>
2. 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/>

### Microprocessor-Based Controls

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | HVAC |
| Measure Last Reviewed | February 2025 |
| Changes Since Last Version | * Renamed to “Microprocessor-Based Controls” from “Electronic Fuel-Use Economizer” * Added electric savings for AC applications |

Description

These devices provide intelligent microprocessor-based control logic for commercial steam and hydronic heating systems and commercial air conditioning systems. They optimize energy consumption by adjusting burner or compressor run patterns to match the system’s load. They can be used to control gas or oil consumption for any type of boiler or forced air furnace system.

Baseline Case

A heating or cooling system system without an intelligent microprocessor control-fuel use economizer.

Efficient Case

A heating or cooling system system with an intelligent microprocessor control.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

Annual Fuel Savings

Where,

To calculate savings in gallons of delivered fuel, use Table 3‑200.

Table 3‑200 Fuel Savings in Gallons

|  |  |
| --- | --- |
| Delivered Fuel | Fuel savings (gallons) |
| Oil |  |
| Propane |  |

Annual Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑201 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak electric savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric savings | Calculated | kWh |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ThermsAnnual | Annual consumption of uncontrolled boiler or furnace | Calculated | Therms/yr |  |
| Cap | Heating capacity of uncontrolled boiler or furnace | Site-specific | Btu/h |  |
| Eff | Heating efficiency of uncontrolled boiler or furnace | Site-specific | N/A |  |
| EFLHh | Effective full-load hours, heating | Look up in Appendix C: Heating and Cooling EFLH | Hr/yr |  |
| EFLHc | Effective full-load hours, cooling | Look up in Appendix C: Heating and Cooling EFLH | Hr/yr |  |
| Fsvg,c | Approximate energy savings factor, cooling | 0.144 | N/A | [602] |
| Fsvg,h | Approximate energy savings factor, heating | 0.128 | N/A | [602] |
| 100,000 | Conversion from Btu to therm | 100,000 | Therm/Btu |  |
| 1.4 | Conversion from therms to gallons of oil | 1.4 | Therms/gal | 0 |
| 0.916 | Conversion from therms to gallons of propane | 0.916 | Therms/gal | 0 |
| PDF | Gas peak day factor | Lookup in Table 3‑152 | N/A |  |
| EUL | Effective useful life | See  Measure Life | Years |  |

Peak Factors

Table 3‑202 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Natural gas peak day factor (PDF) | Look up in Appendix G |  |

Measure Life

The effective useful life (EUL) is the smaller of the economizer EUL of 15 years or the RUL of the host equipment [601].

References

1. New Jersey Board of Public Utilities, New Jersey’s Clean Energy ProgramTM Protocols to Measure Resource Savings, FY2021 Addendum, Appendix A Measure Lives
2. Intellidyne LLC & Brookhaven National Laboratories, *NYSERDA: A Technology Demonstration and Validation Project for Intellidyne Energy Saving Control*, March 2007, Page 3, Table 2, Average of the Four Degree Day Adjusted Heating Sites

<http://smartbuildingproducts.com/casestudies/files/NYSERDA%20final%20report%203-23-07.pdf>

Oak Ridge National Laboratory*, Fuel Conversions Needed in the Weatherization Assistant*, <https://weatherization.ornl.gov/wp-content/uploads/2018/05/FuelConversions.pdf>

### 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:

If fuel heat:

Where,

Annual Fuel Savings

If fuel heat:

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑203 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhcool | Annual cooling electric energy savings | Calculated | kWh/yr |  |
| ΔkWhheat | Annual heating electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Caph | Heating Capacity | Site-specific | Btu/hr |  |
| Capc | Cooling capacity | Site-specific | Tons |  |
| Th | Occupied heating setpoint temperature | Site-specific | °F |  |
| Tc | 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. If equipment age unknown, use vintage efficiency for site-specific equipment type in Appendix E: Code-Compliant Efficiencies | N/A |  |
| EER | Cooling Energy Efficiency Ratio | Site-specific. If unknown, use code compliant efficiency when the equipment was new. If equipment age unknown, use vintage efficiency for site-specific equipment type in Appendix E: Code-Compliant Efficiencies | Btu/hr-W |  |
| Hrswk | Weekly occupied hours[[137]](#footnote-139) | Site-specific; default to 84 | Hr/wk |  |
| Sh | Heating setback temperature | Site-specific; default to Th - 5 | °F |  |
| Sc | Cooling setback temperature | Site-specific; default to Tc + 5 | °F |  |
| Ph | Heating savings fraction per degree of setback | 0.03 | N/A | [603] |
| Pc | Cooling savings fraction per degree of setback | 0.06 | N/A | [603] |
| EFLHh | Heating Equivalent Full Load Hours. Measure applicable to Motel, Hotel and Dormitory building types only. | Look up in Appendix C: | Hr | [604] |
| EFLHc | Cooling Equivalent Full Load Hours. Measure applicable to Motel, Hotel and Dormitory building types only. | Look up in Appendix C: | Hr | [604] |
| 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 3‑204 | kW/kWh |  |
| PDF | Peak day factor | Look up in Table 3‑204 |  |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 3‑204 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.65 | [605] |
| 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

1. ENERGY STAR Programmable Thermostat Calculator. Savings assumptions per 2004 Industry Data.
2. Simulations of prototypical buildings from the NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.
3. Average of Massachusetts Utilities summer coincidence factors. Massachusetts eTRM, 2020 update, measure code COM-HVAC-HOS. Available online: <https://www.masssavedata.com/Public/TechnicalReferenceLibrary>

### Smart Thermostats

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/RF |
| Baseline | Code/ISP/Existing |
| End Use Subcategory | HVAC Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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[607] or has followed the ENERGY STAR product requirements[608].

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 [609]. 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

Where,

Annual Fuel Savings

Peak Demand Savings[[138]](#footnote-140)

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| CCAP | Cooling capacity of existing AC unit | Site-specific | kBtu/hr |  |
| Effcool | Cooling efficiency of controlled unit (SEER, SEER2, or IEER). For GSHP, use EER. | Site-specific, if unknown look up in Appendix | Btu/W-h |  |
| HCAPfuel | Heating capacity of existing furnace unit | Site-specific | MMBtu/hr |  |
| AFUE | Annual Fuel Utilization Efficiency | Site-specific, if unknown look up in Appendix | N/A |  |
| HCAPelec | 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. For electric resistance heat, use 3.412 | Btu/W-h |  |
| SFelec,c | Electrical cooling percent savings from thermostat relative to baseline control | Look up in Table 3‑206 | % | [611][612] |
| SFelec,h | Electrical heating percent savings from thermostat relative to baseline control | Look up in Table 3‑206 | % | [611][612] |
| SFfuel | Heating fuel percent savings from thermostat relative to baseline control. | Look up in Table 3‑206 | % | [611][612] |
| EFLHc | Full load hours for cooling equipment | Look up in Appendix | Hrs/yr | [606] |
| EFLHh | Full load hours for heating equipment | Look up in Appendix | Hrs/yr | [606] |
| CF | Electric coincidence factor | Look up in Table 3‑207 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑207 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑206 Saving Factors for Smart Thermostats by Baseline Technology

|  |  |  |  |
| --- | --- | --- | --- |
| Fuel and Function | Baseline Technology | | |
| **Manual Thermostat** | **Programmable Thermostat** | **Unknown** |
| Savings factor for electric cooling, SFelec,c | 5% | 3% | 3% |
| Savings factor for electric heating, SFelec,h | 4% | 2% | 2% |
| Savings factor for fuel heating, SFfuel | 5% | 2% | 2% |

Peak Factors

Table 3‑207 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 7.5 years [610].

References

1. Simulations of prototypical buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022.
2. ENERGY STAR’s qualified products list for smart thermostats: <https://data.energystar.gov/dataset/ENERGY-STAR-Certified-Connected-Thermostats/7p2p-wkbf>
3. 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>
4. 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.
5. 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>
6. 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](http://www.michigan.gov/documents/mpsc/CI_Programmable_TStats_MEMD_6_15_15_491808_7.pdf%20)
7. 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/](%20https:/www.clearesult.com/insights/whitepapers/guide-to-smart-thermostats/%20)
8. 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>

### 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

Annual Fuel Savings

Where,

Annual Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑208 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Losssteam | 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 3‑210 | psi | [614] |
| Eff | Thermal efficiency of boiler | Site-specific, if unknown look up in Table 3‑210 | Et or AFUE | [614] |
| Hrs | Annual hours trap pressurized | Site-specific, if unknown look up in Table 3‑210 | Hours | [614] |
| ID | Internial diameter of steam trap orifice | Site-specific, if unknown look up in Table 3‑210 | Inches |  |
| FCR | 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 3‑210 | N/A | [614] |
| ΔHvap | Heat of vaporization (latent heat) at system operating pressure | Look up in Table 3‑209 | Btu/lb |  |
| Fdischarge | Discharge coefficient | Look up in Table 3‑210 | N/A | [614] |
| Floss | Steam loss adjustment factor | Look up in Table 3‑210 | N/A | [614] |
| patm | Atmospheric pressure | 14.7 | psi |  |
| 60 | Empirically derived constant in Grashof’s equation | 60 | lbm/ in0.06-lb0.97-hr | [615] |
| π/4 | Orifice area development factor | π/4 | N/A |  |
| 0.97 | Empirically derived constant in Grashof’s equation | 0.97 | N/A | [615] |
| 100,000 | Conversion factor | 100,000 | Btu/therm |  |
| PDF | Gas peak day factor | Lookup in Table 3‑152 | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Table 3‑209 Heat of Vaporization

|  |  |
| --- | --- |
| Gauge Pressure (psig) | Heat of Vaporization (Btu/lb) |
| 0 | 970 |
| 1 | 968 |
| 2 | 966 |
| 5 | 960 |
| 10 | 952 |
| 15 | 945 |
| 20 | 939 |
| 25 | 934 |
| 30 | 929 |
| 40 | 920 |
| 50 | 912 |
| 60 | 905 |
| 70 | 898 |
| 80 | 892 |
| 90 | 886 |
| 100 | 880 |
| 110 | 875 |
| 120 | 871 |
| 125 | 868 |
| 130 | 866 |
| 140 | 861 |
| 150 | 857 |
| 160 | 853 |
| 180 | 845 |
| 200 | 837 |
| 225 | 829 |
| 250 | 820 |

Table 3‑210 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 (Floss) | 0.369 | 0.369 |
| Discharge coefficient (Fdischarge) | 0.70 | 0.70 |
| Condensate return factor (FCR) | 0.363 | 0.363 |

Peak Factors

Table 3‑211 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 [615].

References

1. ERS, “Two-Tier Steam Trap Savings Study”, April 26, 2018. pg 5.
2. Massachusetts Program Administrators and Energy Efficiency Advisory Council, “Steam Trap Evaluation Phase 2” March 8, 2017. Pg. 6.

### Maintenance

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Maintenance |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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

Where,

Annual Fuel Savings

For boilers,

For furnaces,

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑212 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhcool | Annual cooling energy savings | Calculated | kWh/yr |  |
| ΔkWhheat | Annual heating energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Fimprov | Percent improvement in EER/HSPF[[139]](#footnote-141) | Calculated; if EER unknown look up in Table 3‑213[[140]](#footnote-142) | N/A | [616][620] |
| Effimprov,b | EER/EER2 of existing AC Unit or HSPF of existing Heat pumps | Site-specific | EER: BTU/watts  HSPF: BTU/watt-hr |  |
| Effimprov,q | EER/EER2 of efficient AC Unit or HSPF of efficient Heat pumps | Site-specific | EER: BTU/watts  HSPF: BTU/watt-hr |  |
| EERb | EER or EER2 of existing AC Unit | Site-specific | BTU/watts |  |
| Capc | Cooling Capacity of existing AC Unit | Site-specific | kBTU/hr |  |
| Caph | Heating Capacity of existing Heat Pumps | Site-specific | kBTU/hr |  |
| Capin | Fuel input rating per boiler/furnace | Site-specific | kBTU/hr |  |
| Effc,b | Baseline combustion efficiency as determined via flue gas analysis | Site-specific | N/A |  |
| Effc,q | Post-implementation boiler combustion efficiency as determined via flue gas analysis | Site-specific | N/A |  |
| Efff,b | Actual combustion efficiency of the furnace before tune-up, based on flue gas analysis | Site-specific | N/A |  |
| Efff,q | Post-implementation furnace combustion efficiency as determined via flue gas analysis | Site-specific | N/A |  |
| EFLHc | Equivalent Full Load Hours of operation for the average unit during the cooling season | See Appendix C: | Hours | [617] |
| EFLHh | Equivalent Full Load Hours of operation for the average unit during the heating season | See Appendix C: | Hours | [617] |
| SEERb | 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 |  |
| Ffurnace | Energy Savings Factor furnace | For Large Commercial - Calculated;  For Small Commercial (<225 MBH) = 0.05 | N/A | [618] |
| CF | Electric coincidence factor (CF) | Look up in Table 3‑214 | N/A | [620] |
| PDF | Gas peak demand factor | Look up in Table 3‑214 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑213 Percent Improvement in EER (Fimprov)

|  |  |
| --- | --- |
| 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 3‑214 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.478 | [620] |
| 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 [619].

References

1. Energy Center of Wisconsin, *Central Air Conditioning in Wisconsin, A Compilation of Recent Field Research* (May 2008)
2. Simulations of prototype buildings from NY TRM updated with NJ weather done by NJ Statewide Evaluator, May 2022
3. Washington State University Energy Program, Building Tune-Up and Operations Program Evaluation (March 2007), Pg 5
4. DEER 2014 EUL <http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx>
5. *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

### Advanced Rooftop Controls

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Controls |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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 CO2 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 TMYx Data using base 65 F balance point. See the ‘Demand Controlled Ventilation’ Section of the Illinois Statewide Technical Reference Manual V11 for further explanation [623].

**It is important to note that only those components that are not required by code are eligible for savings.** See ASHRAE 90.1-2019 section 6.4.3.

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

Where

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhlife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermslife | Lifetime fuel savings | Calculated | Therms |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhfan | Annual electricity energy savings resulting from supply fan control | Calculated | kWh/yr |  |
| ΔkWhDCV | Annual electricity energy savings resulting from DCV | Calculated | kWh/yr |  |
| ΔkWhEcon | Annual electricity energy savings resulting from economizer | Calculated | kWh/yr |  |
| hp | Horsepower of RTU supply fan | Site-specific | hp |  |
| ESFfan | Energy savings factor for supply fan control[[141]](#footnote-143) | 0.580 | kWh/hp/hr | [621] |
| hrs | Annual operating hours of RTU supply fan | Site-specific if unknown use default values in Table 3‑216 | Hrs/yr | [622] |
| A | Total area square footage of the conditioned space impacted by the measure | Site-specific | Ft2 |  |
| SFElecCool | DCV energy savings factor for cooling | Look up in Table 3‑217 | kWh/1,000 ft2 | [623] |
| SFElecHeat | DCV energy savings factor for electric heating | Look up in Table 3‑218, Table 3‑219 | kWh/1,000 ft2 | [623] |
| FelecHeat | 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 |  |
| SFecon | Annual electric energy savings per ton of cooling resulting from economizer | Look up in Table 3‑221 | kWh/ton | [624] |
| SFFuel | DCV fuel savings factor for heating | Look up in Table 3‑220 | therms/1,000 ft2 | [623] |
| FFuelHeat | 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 3‑222 | N/A | [625] |
| PDF | Gas peak day factor | Look up in Table 3‑222 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑216 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 3‑217 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 |
| 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 3‑218 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 3‑219 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 3‑220 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 |
| 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 3‑221 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 3‑222 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [625] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 5 years [626]

References

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3. 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>
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6. 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>

## Shell

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑223 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| SF | Building square feet of conditioned floor area affected by installation | Site-specific | ft2 |  |
|  | Annual electric energy savings per thousand square feet | Lookup Table 3‑224 | kWh/ft2 | [628] |
|  | Peak coincident demand electric savings per thousand square feet | Lookup Table 3‑224 | kWh/ft2 | [628] |
|  | Annual gas energy savings per thousand square feet | Lookup Table 3‑224 | Therms/ ft2 | [628] |
| 1,000 | Conversion Factor from square feet (SF) to 1,000 square feet (kSF) | 1000 | N?A |  |
| CF | Coincidence factor | Lookup in Table 3‑225 | N/A |  |
| PDF | Gas peak day factor | Lookup in Table 3‑225 | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Table 3‑224 Impact per thousand square feet[[142]](#footnote-144)

|  |  |  |  |
| --- | --- | --- | --- |
| Vintage |  |  |  |
| Old | 118 | 0.119 | 29 |
| Average | 56 | 0.098 | 17 |

Peak Factors

Table 3‑225 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Coincidence factor | 0.69 | [629] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 15 years [627].

References

1. 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. New York State Joint Utilities, New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, V10, pg. 1222, January 2023.
3. 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.

### Commercial and Industrial Air Sealing

|  |  |
| --- | --- |
| Market | Commercial and Industrial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Shell |
| Measure Last Reviewed | February 2025 |
| Changes Since Last Version | * New Measure |

Description

This measure covers methods of sealing air leakage paths to reduce the natural air infiltration rate of a building through the installation of products and repairs to the building envelope, including, but not limited to, caulking, gasketing, and weather stripping. Sealing the thermal envelope reduces passive convective heat transfer between conditioned and unconditioned spaces or outside air, thereby reducing heating and cooling loads and improving occupant comfort. This measure is only applicable as a retrofit in existing buildings. This measure is not applicable to gut rehab/major renovation projects, which entail whole-building envelope alterations that trigger more stringent code provisions, limiting potential incremental savings.

In cases where blower door testing is conducted before and after implementation of air sealing treatments, those measurements shall be utilized in the estimation of energy impacts via the method below. A blower door test is performed to measure the leakage rate by depressurizing the building to a standard pressure difference of 75 Pascals or 0.3 inches of water. The flowrate indicates the leakage rate, or infiltration and exfiltration rate, of the building shell.

Baseline Case

Existing building envelope with natural air infiltration.

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑226 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
|  | Baseline infiltration rate (cubic foot per minute per building square foot) at a negative pressure differential of 75 Pa or 0.3 inches of water | Site-specific, results from blower door test. If pre-implementation blower door test results are unavailable, use 0.40 CFM75/SF as default.[[143]](#footnote-145) | ft3/min |  |
|  | Efficient infiltration rate (cubic foot per minute per building square foot) at a negative pressure differential of 75 Pa or 0.3 inches of water | Site-specific, results from blower door test. If post -implementation blower door test results are unavailable, use 0.25 CFM75/SF as default.[[144]](#footnote-146),[[145]](#footnote-147),[[146]](#footnote-148) | ft3/min |  |
|  | = Square footage of the above- and below-grade building envelope | Site-specific | ft2 |  |
|  | Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, climate zone factor | 19 | N/A | [634] |
|  | Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, building height factor. Based on the number of conditioned stories in the building, from application[[147]](#footnote-149). The selected value should reflect the number of stories located inside the conditioned envelope of the building. Unconditioned basements and attics should not be included. Upper levels without full height perimeter walls shall be considered as half-stories (0.5). |  | N/A | [634] |
|  | Latent Multiplier, converts the sensible cooling load savings captured in the savings equation to a savings capturing both latent and sensible load savings.[[148]](#footnote-150) | Look up in Table 3‑228 | N/A |  |
|  | Cooling Degree Day | Look up in Table 3‑227 | F-day/yr | [638] |
|  | Heating Degree Day | Look up in Table 3‑227 | F-day/yr | [638] |
| Effelec,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 | [635] |
| HSPF | Heating seasonal performance factor of electric heating equipment[[149]](#footnote-151) | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size | Btu/watt-hour | [635] |
| EER/EER2 | Efficiency in EER of Air Conditioning equipment | Site-specific. If unknown, see Appendix E: Code-Compliant Efficiencies | Btu/W-h | [635] |
| EffFuelHeat | Efficiency of fossil fuel heating equipment (AFUE, Et or Ec) | Site-specific, if unknown look up in Appendix E: Code-Compliant Efficiencies for equipment type and size |  | [635] |
| FElecHeat | Electric heating factor, to account for presence of electric heat | Use 1 if electric heat, otherwise use 0 | N/A |  |
| FFuelHeat | Fuel heating factor, to account for presence of fuel heat | Use 1 if fuel heat, otherwise use 0 | N/A |  |
|  | Coincidence factor | Look up in Table 3‑229 | N/A |  |
| 1.08 | Specific heat of air x density of inlet air at 70ºF x 60 min/hr, in BTU/h-ºF-CFM | 1.08 | BTU/h.°F.CFM |  |
|  | Hours in a day | 24 | hrs |  |
|  | Conversion factor | 1,000 | Watts/kW |  |
|  | Conversion factor | 1,000,000 | Btu/MMBtu |  |
| 10 | Conversion factor | 10 | Therm/Btu |  |

Table 3‑227 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 |

Table 3‑228 Latent Multiplier

|  |  |  |  |
| --- | --- | --- | --- |
| Location | Latent Load | Sensible Load | Latent Multiplier (LM) [[150]](#footnote-152) |
| Atlantic City | 4.1 | 0.6 | 7.8 |
| Newark | 3.1 | 0.6 | 6.2 |

Peak Factors

Table 3‑229 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.5 | [13] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 15 years. [643]

References

1. ECCCNYS 2020 Section C402.5 Air leakage – thermal envelope (Mandatory). Available from: https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-ce-commercial-energy-efficiency#NYSECC2020P1\_CE\_Ch04\_SecC402
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4. National Institute of Standards and Technology, Analysis of U.S. Commercial Building Envelope Air Leakage Database to Support Sustainable Building Design. Available from: https://tsapps.nist.gov/publication/get\_pdf.cfm?pub\_id=914293
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11. Infiltration Factor Calculation Methodology, Bruce Harley, Senior Manager, Applied Building Science, CLEAResult. As captured in Appendix A of the Illinois Technical Advisory Committee’s Memorandum, TRM Version 5 Draft 1 Review – Second Measure Group, November 25, 2015. Available from: [https://www.ilsag.info/wp-content/uploads/SAG\_files/Technical\_Reference\_Manual/Version\_5/IL\_TAC\_Second\_ Measure\_Group\_Draft\_Memo\_11-25-2015.pdf](https://www.ilsag.info/wp-content/uploads/SAG_files/Technical_Reference_Manual/Version_5/IL_TAC_Second_%20Measure_Group_Draft_Memo_11-25-2015.pdf)
12. ASHRAE Journal, Dehumidification and Cooling Loads From Ventilation Air, Lewis Harriman, November 1997.
13. 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. Available from: http://www.neep.org/sites/default/files/resources/NEEP\_HVAC\_Load\_Shape\_Report \_Final\_August2\_0.pdf.
14. GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures

### Dock Door Seals and Shelter

|  |  |
| --- | --- |
| Market | Commercial and Industrial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | N/A |
| Measure Last Reviewed | February 2025 |
| Changes Since Last Version | * New Measure |

Description

This measure applies to buildings with exterior doors that serve as loading docks.

Overhead dock doors allow for loading and unloading of trucks. When the truck backs into the dock bumpers, a gap is created between the truck and the dock door that allows the infiltration or exfiltration of air in the upper, lower, and side portions. The infiltration/exfiltration of cold and warm air during the heating and cooling seasons increases the energy load of the building. Dock door seals are foam panels that are mounted outside of the dock door. Dock shelters are structures that form an enclosure around the perimeter of the trailer and are mounted outside of the dock door. The addition of dock door seals and shelters forms a tight seal between the truck and the door that prevents air infiltration/exfiltration and results in energy savings and enhanced personal comfort. Dock door seals and shelters also prevent the passing of rain droplets, snow, dust, insects, and other airborne particles.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified.

Baseline Case

Dock doors with no seals or shelters installed to effectively reduce heat loss and air during truck loading and unloading.

Efficient Case

Dock doors with compression seals or shelters forming a tight seal around the top, bottom, and sides of the truck and installed following manufacturer guidelines to effectively reduce heat loss and air during truck loading and unloading.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Where,

Heat Transfer Through Open Dock Door Without Dock Door Seal or Shelter (during Cooling Season)

The total airflow through the gaps, , includes both infiltration due to wind as well as thermal forces, as follows:

The infiltration due to the wind is calculated as follows:

The infiltration due to thermal forces is calculated as follows:

Note, values for show little variation due to balance point temperature, indoor air temperature, and climate zone. As such, if estimating results, the NJ average value of 0.39 at indoor air temp of 70˚F may be used as a simplification.

Annual Fuel Savings

Heat Transfer Through Open Entryway (Heating Season)

The total airflow through the entryway, , includes both infiltration due to wind as well as thermal forces, as follows:

The infiltration due to the wind is calculated as follows:

The infiltration due to thermal forces is calculated as follows:

Where,

Note, values for Cdh show little variation due to balance point temperature, indoor air temperature, and climate zone. As such, if estimating results, the NJ average value of 0.46 at indoor air temp of 70˚F may be used as a simplification.

Peak Demand Savings

Daily Peak Fuel Savings

Δ𝑇ℎ𝑒𝑟𝑚𝑠𝑃𝑒𝑎𝑘= Δ𝑇ℎ𝑒𝑟𝑚𝑠 X PDF

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑230 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔkWhcooling | Annual electric cooling energy savings | Calculated | kWh/yr |  |
| ΔkWhheating | Annual electric heating energy savings | Calculated | kWh/yr |  |
|  | Rate of total heat transfer through the gap before dock door seal or shelter | Calculated | kBtu/hr |  |
|  | Infiltration due to the wind | Calculated | Cfm |  |
|  | Infiltration due to thermal forces | Calculated | Cfm |  |
|  | Total air flow through gaps | Calculated | cfm |  |
| H | Dock door height | Site-specific |  |  |
|  | Leakage Area (gap) between doorway and truck[[151]](#footnote-153) | Site-specific, or assume 16.8 | ft2 | [648] |
|  | Average indoor air temperature during cooling season | Site-specific, if unknown use 70°F | ˚F | [648] |
|  | Efficiency of heating equipment | Site specific, if unknown, assume 0.8 | AFUE | [646] |
|  | Average indoor air temperature during heating season | Site-specific, if unknown use 70°F | ˚F | [648] |
| EER | Energy efficiency ratio of electric cooling equipment[[152]](#footnote-154) | Site-specific, if unknown look up in Appendix E for equipment type and size | Btu/watt-hour | [646] |
| HSPF | Heating seasonal performance factor of electric heating equipment[[153]](#footnote-155) | Site-specific, if unknown look up in Appendix E for equipment type and size | Btu/watt-hour | [646] |
|  | Average hours per day that a truck is in the loading position and the truck dock door is open[[154]](#footnote-156) | 8.39 | hr/day | [645] |
| CD | Operating days in the cooling season | Look up in Table 3‑232 | Days |  |
| HD | Operating days in the heating season | Look up in Table 3‑232 | days |  |
| 4.5 | Unit conversion factor with density of air: 60 min/hr \* 0.075 lbm/ft3 | 4.5 | Lb-min/ft3-hr |  |
| hoc | Average outdoor enthalpy during cooling season | Look up in Table 3‑231 | Btu/lb |  |
| hic | Average enthalpy of indoor air, cooling season | Look up in Table 3‑233 | Btu/lb |  |
|  | Average wind speed during the cooling season based on entryway orientation[[155]](#footnote-157) | Look up in Table 3‑234 | Mph | [647] |
|  | Wind speed correction factor due to wind direction in cooling season[[156]](#footnote-158) (%) | Look up in Table 3‑236 |  | [647] |
|  | Effectiveness of openings, assumes diagonal wind[[157]](#footnote-159) | 0.3 |  | [647] |
|  | Eischarge coefficient during cooling season[[158]](#footnote-160),[[159]](#footnote-161) | 0.42 |  | [647] |
|  | Average outdoor temperature during cooling season | Look up in Table 3‑231 | ˚F |  |
|  | Wind speed correction factor due to wind direction in heating season, | Look up in |  | [647] |
|  | Average wind speed during heating season | Look up in Table 3‑235 | (mph) | [647] |
| Cdh | Discharge coefficient during heating season | 0.46 |  | [647] |
| g | Acceleration due to gravity | 32.2 | ft/sec2 |  |
| 459.7 | Conversion factor from ˚F to ˚R[[160]](#footnote-162) | 459.7 | N/A |  |
| 1.08 | Sensible heat transfer coefficient: specific heat of air and unit conversions, | 1.08 | BTU/h.°F.CFM |  |
|  | Average outdoor temp during heating season | Look up in Table 3‑231 | ˚F |  |

Table 3‑231 Outdoor Air Temperature and Enthalpy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NJ Climate Region | Relative Humidity[[161]](#footnote-163) (%) | Avg. outdoor temperature[[162]](#footnote-164) during cooling season, Toutdoor,c (°F) | Avg. outdoor temperature134 during heating season, Toutdoor,h (°F) | Avg enthalpy[[163]](#footnote-165) of outdoor air at during cooling season, Houtdoor,c (Btu/lb) | Avg enthalpy135 of outdoor air at during heating season, Houtdoor,c (Btu/lb) |
| Northern | 69.77 | 74.60 | 42.10 | 32.05 | 14.39 |
| Southern | 67.39 | 74.50 | 42.70 | 31.51 | 14.49 |
| 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 3‑232 Cooling days per year and heating days per year[[164]](#footnote-166)

|  |  |  |
| --- | --- | --- |
| NJ Climate Region | Heating days | Cooling, days |
| Northern | 207 | 70 |
| Southern | 204 | 74 |
| Coastal | 208 | 81 |
| Central | 207 | 75 |
| Pine Barrens | 204 | 76 |

Table 3‑233 Indoor Enthalpy

|  |  |
| --- | --- |
| Temperature, Tindoor (°F) | Enthalpy, Hindoor 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 |
| 73 | 27.0 |
| 74 | 27.5 |
| 75 | 28.1 |
| 76 | 28.7 |
| 77 | 29.3 |
| 78 | 29.9 |

Table 3‑234 Average wind speed during the cooling season based on entryway orientation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NJ Climate Region | N | E | S | W | Unknown (average) |
| Northern | 3.8 | 4.3 | 4.6 | 6.2 | 5.2 |
| Central | 3.5 | 3.4 | 3.7 | 4.2 | 3.8 |
| Pine Barrens | 4.6 | 3.1 | 3.8 | 4.7 | 4.2 |
| Southwest | 4.3 | 3.4 | 3.8 | 4.5 | 4.1 |
| Coastal | 4.5 | 4.8 | 5.6 | 5.4 | 5.2 |

Table 3‑235 Average wind speed during the heating season based on entryway orientation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NJ Climate Region | N | E | S | W | Unknown (average) |
| Northern | 3.5 | 3.4 | 4.0 | 4.1 | 3.8 |
| Central | 3.1 | 3.2 | 3.0 | 3.0 | 3.1 |
| Pine Barrens | 3.5 | 2.3 | 2.7 | 2.9 | 3.0 |
| Southwest | 3.4 | 3.6 | 2.7 | 3.9 | 3.5 |
| Coastal | 2.9 | 3.8 | 4.5 | 3.9 | 3.9 |

Table 3‑236 Wind speed correction factor due to wind direction in cooling season (%)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NJ Climate Region | N | E | S | W | Unknown (average) |
| Northern | 0.16 | 0.11 | 0.18 | 0.20 | 0.16 |
| Central | 0.13 | 0.10 | 0.20 | 0.08 | 0.13 |
| Pine Barrens | 0.13 | 0.05 | 0.14 | 0.15 | 0.12 |
| Southwest | 0.11 | 0.05 | 0.11 | 0.20 | 0.12 |
| Coastal | 0.09 | 0.11 | 0.29 | 0.09 | 0.15 |

Table 3‑237 Wind speed correction factor due to wind direction in heating season (%)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NJ Climate Region | N | E | S | W | Unknown (average) |
| Northern | 0.11 | 0.14 | 0.09 | 0.32 | 0.17 |
| Central | 0.13 | 0.07 | 0.15 | 0.20 | 0.14 |
| Pine Barrens | 0.17 | 0.13 | 0.23 | 0.39 | 0.23 |
| Southwest | 0.24 | 0.06 | 0.11 | 0.16 | 0.14 |
| Coastal | 0.12 | 0.10 | 0.15 | 0.33 | 0.18 |

Peak Factors

Table 3‑238 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.50 | [648] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 15 years.

References

1. ASHRAE, “Ventilation and Infiltration,” in 2013 ASHRAE Handbook – Fundamentals (2013): Ch 16.1 - 16.37.
2. https://www.novalocks.com/wp-content/uploads/Dock-Planning-Standards-Guide.pdf
3. N. J. B. o. Utilities, "New Jersey 2023 Triennial Technical Reference Manual, APPENDIX E: CODE-COMPLIANT EFFICIENCIES, Section 8.2," 2023.
4. ASHRAE, "Ventilation and Infiltration," ASHRAE Handbook – Fundamentals, p. 16.13, 2013
5. 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.

## Lighting

### Lighting Fixtures

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/EREP/DI |
| Baseline | Code/Existing |
| End Use Subcategory | Lighting Fixtures |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version | * Updated HVAC interactivity factors lookup |

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 installed 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 [650].

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 3‑241 whereas the building area method involves applies applying a uniform LPD to the entire building using values from Table 3‑240.

The exterior lighting power allowance is calculated as follows.

1. Determine the lighting zone from Table 3‑242.
2. Determine the applicable category and space type from Table 3‑243
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 3‑243, 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 [650] with adjustments for standard practice [7].

New Construction Exterior Lighting: Baseline lighting LPA based on the IECC 2021 Code [650] with adjustments for standard practice [7].

Replacement: Actual existing fixture/lamp wattage. If unknown, use wattage from Appendix L: Lighting Wattages Table 15.2 [649].

Mid-Stream Lighting: Lookup in Appendix L: Lighting Wattages Table 15.1

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:

New Construction Exterior Lighting:

Replacement/Midstream Interior Lighting:

Replacement/Midstream Exterior Lighting:

Annual Fuel Savings

Replacement/Midstream Interior Lighting:

New Construction Interior Lighting:

***Note:*** *No fuel impacts are claimed in exterior lighting installation.*

Peak Demand Savings

Retrofit Interior Lighting:

Retrofit Exterior Lighting:

New Construction Interior Lighting:

New Construction Exterior Lighting

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

For NC/TOS:

For EREP/DI:

Lifetime Fuel Energy Savings

For NC/TOS:

For EREP/DI:

Calculation Parameters

Table 3‑239 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| Qtyb | Quantity of replaced fixtures | Site-specific | N/A |  |
| Qtyq | Quantity of qualifying fixtures | Site-specific | N/A |  |
| Wb | Wattage of baseline fixture | Site-specific, if unknown see Appendix L: Lighting Wattages | W | [649] |
| Wq | Wattage of qualifying fixture (per DLC or ENERGY STAR certification, or manufacturer's cutsheet if certification not required by program) | Site-specific | W |  |
| LPDq | Installed lighting power density | Site-specifiic | W/Sq Ft |  |
| LPDb | Baseline lighting power density | Site-specific, if unknown look up in Table 3‑240, Table 3‑241, Table 3‑243 | W/Sq Ft |  |
| LPAb | Baseline lighting power allowance | Site-specific, if unknown look up in Table 3‑243 | W/Sq Ft or W/ Linear Ft | [650] |
| LPAq | Installed lighting power allowance | Site-specific, if unknown look up in Table 3‑243 | W/Sq Ft or W/ Linear Ft | [650] |
| 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 3‑244 | Hrs/yr | [622] |
| LPDAF (interior) | Interior Lighting LPD adjustment factor (25% better) | 0.75 | N/A | [655] |
| LPAAF (exterior) | Exterior Lighting LPA adjustment factor (35% better) | 0.65 | N/A | [655] |
| HVACc | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [672][674] |
| HVACff | HVAC Interactive Factor for Annual Fossil Fuel Savings | Look up in Appendix F: HVAC Interactivity Factors | MMBtu/kWh | [659] |
| HVACd | HVAC Interactive Factor for Peak Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [672][674] |
| CF | Coincidence Factor | Look up in Table 3‑244 | N/A | [622] |
| SVGb | Savings control factor | Look up in Table 3‑245 |  | [658] |
| PDF | Gas peak day factor | Look up in Table 3‑246 |  |  |
| AML | Adjusted measure life for EREP/DI | See Measure Life Section | Years |  |
| EUL | Effective useful life for NC/TOS | 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 3‑240 Baseline Lighting Power Density (Building Area Method) – IECC 2021 Standard Section C405.3.2(1) [650]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 |
| 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 3‑241 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 |
| **Dining area** | |  | *Open plan* | 0.61 |
| *In bar/lounge or leisure dining* | 0.86 |  | **Parking area, interior** | 0.15 |
| *In cafeteria or fast food dining* | 0.4 |  | **Pharmacy area** | 1.66 |
| *In a facility for the visually impaired (and not used primarily by the staff)b* | 1.27 |  | **Performing arts theater—dressing room** | 0.41 |
| *In family dining* | 0.6 |  | **Post office—sorting area** | 0.76 |
| *In a penitentiary* | 0.42 |  | **Religious buildings** | |
| *Otherwise* | 0.43 |  | *In a fellowship hall* | 0.54 |
| **Dormitory—living quartersc, d** | 0.5 |  | *In a worship/pulpit/choir area* | 0.85 |
| **Electrical/mechanical room** | 0.43 |  | **Restroom** | |
| **Emergency vehicle garage** | 0.52 |  | *In a facility for the visually impaired (and not used primarily by the staffb* | 1.26 |
| **Facility for the visually impairedb** | |  | *Otherwise* | 0.63 |
| *In a chapel (and not used primarily by the staff)* | 0.7 |  | **Retail facilities** | |
| *In a recreation room (and not used primarily by the staff)* | 1.77 |  | *In a dressing/fitting room* | 0.51 |
| **Fire Station—sleeping quartersc** | 0.23 |  | *In a mall concourse* | 0.82 |
| **Food preparation area** | 1.09 |  | **Sales area** | 1.05 |
| **Guestroomc, d** | 0.41 |  | **Seating area, general** | 0.23 |
| **Gymnasium/fitness center** | |  | **Stairwell** | 0.49 |
| *In an exercise area* | 0.9 |  | **Sports arena—playing area** | |
| *In a playing area* | 0.85 |  | *For a Class I facilitye* | 2.94 |
| **Healthcare facility** | |  | *For a Class II facilityf* | 2.01 |
| *In an exam/treatment room* | 1.4 |  | *For a Class III facilityg* | 1.3 |
| *In an imaging room* | 0.94 |  | *For a Class IV facilityh* | 0.86 |
| *In a medical supply room* | 0.62 |  | **Storage room** | 0.38 |
| *In a nursery* | 0.92 |  | **Transportation facility** | |
| *In a nurse’s station* | 1.17 |  | *At a terminal ticket counter* | 0.51 |
| *In an operating room* | 2.26 |  | *In a baggage/carousel area* | 0.39 |
| *In a patient roomc* | 0.68 |  | *In an airport concourse* | 0.25 |
| *In a physical therapy room* | 0.91 |  | **Vehicular maintenance area** | 0.6 |
| *In a recovery room* | 1.25 |  | **Warehouse—storage area** | |
| **Laboratory** | |  | *For medium to bulky, palletized items* | 0.33 |
| *In or as a classroom* | 1.11 |  | *For smaller, hand-carried items* | 0.69 |
| *Otherwise* | 1.33 |  | **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 3‑242 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 3‑243 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 |
| **Non-Tradable Surfaces** | Building facades | | W/ft2 of gross above-grade wall area | - | 0.075 | 0.113 | 0.15 |
| 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/ft2 | 0.5 | 0.5 | 0.5 | 0.5 |
| Uncovered loading areas for law enforcement, fire, ambulance, and other emergency vehicles | | W/ft2 | 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 3‑244 Hours of Use and Coincidence Factor by Building Type

|  |  |  |  |
| --- | --- | --- | --- |
| Building Type | Sector | CF | Hours |
| Grocery | Large Commercial/Industrial & Small Commercial | .99 | 7580 |
| Medical – Clinic | Large Commercial/Industrial & Small Commercial | 1.0 | 3,909 |
| Medical - Hospital | Large Commercial/Industrial & Small Commercial | 1 | 8,760[[165]](#footnote-167) |
| 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 | 0.92 | 5593 |
| Small Commercial | 0.86 | 4,926 |
| School | Large Commercial/Industrial & Small Commercial | 0.50 | 2,575 |
| Warehouse/ Industrial | Large Commercial/Industrial | 0.79 | 4,116 |
| Small Commercial | 0.65 | 2422 |
| Outside/Outdoor Area | All | 0.0 | 4305 (Parking)  4380 (Other) |
| Parking Garage | All | 0.98 | 8,678 |
| Multifamily – Common Areas[[166]](#footnote-168) | Multifamily | 1.0 | 8760 |
| Multifamily – In-Unit | Multifamily | 0.06 | 679 |
| Multifamily –Exterior | Multifamily | 0.00 | 3,338 |
| College/University - Cafeteria[[167]](#footnote-169) | All | 0.79 | 2,713 |
| College/University – Classes3 | All | 0.54 | 2,586 |
| College/University - Dormitory3 | All | 0.92 | 3,066 |
| Religious Building3 | All | 0.89 | 1,955 |
| Nursing Home3 | All | 0.92 | 5,840 |
| Restaurant - Dine-In168 | All | 0.79 | 4,182 |
| Restaurant - Fast food168 | All | 0.79 | 6,456 |
| Museum168 | All | 0.89 | 3,748 |

Table 3‑245 Baseline SVG Values

|  |  |
| --- | --- |
| **Building Type** | **SVGbase** |
| Education | 17% |
| Exterior | 0% |
| Grocery | 5% |
| 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 3‑246 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | Look up in Table 3‑244 | [622] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

Table 3‑247 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | AML (for EREP/DI) | EUL (for NC/TOS) | Ref |
| LED Fixture | 5 | Fixture rated life in hours ÷ operating hours from Table 3‑244. Not to exceed 15 yr. | [656] |
| LED Fixture with Controls | 7 | Fixture rated life in hours ÷ operating hours from Table 3‑244. Not to exceed 15 yr. | [656] |
| TLED | 5 | N/A | [656] |
| High Bay/Low Bay LED Fixture | 7 | Fixture rated life in hours ÷ operating hours from Table 3‑244. Not to exceed 15 yr. | [656] |
| High Bay/Low Bay LED Fixture with Controls | 8 | Fixture rated life in hours ÷ operating hours from Table 3‑244. Not to exceed 15 yr. | [656] |
| High Bay/Low Bay TLED | 6 | N/A | [656] |
| Exterior/Outdoor LED Fixture | 7 | Fixture rated life in hours ÷ operating hours from Table 3‑244. Not to exceed 15 yr. | [656] |
| Exterior/Outdoor LED Fixture with Controls | 8 | Fixture rated life in hours ÷ operating hours from Table 3‑244. Not to exceed 15 yr. | [656] |
| Exterior/Outdoor TLED | 6 | N/A | [656] |
| Screw-in LEDs | 1 | N/A | [657] |

References

1. 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
2. ‌ “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.
3. ‌ 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)
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7. DNV, *New Jersey Commercial New Construction Industry Standard Practice Analysis. Prepared for Rutgers University and the NJ Board of Public Utilities.* (2022).
8. DNV, N*ew Jersey Non-Residential Lighting Market Characterization*. *Prepared for Rutgers University and the NJ Board of Public Utilities.* (2022).
9. 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.
10. *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/>
11. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

### Lighting Controls

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | NC/RF |
| Baseline | ISP/Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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 is 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

*Bi-level Lighting*

*Where,*

Annual Fuel Savings

Normal or Networked Lighting

*Bi-level Lighting*

Peak Demand Savings

Normal or Networked Lighting

*Bi-level Lighting*

*Where,*

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑248 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ESF | Energy savings factor | Calculated | N/A |  |
| SVGbl | Percent of annual lighting energy saved by the bi-level lighting control | Calculated | N/A |  |
| SVGbl,demand | Percent of annual lighting demand energy saved by the bi-level lighting control | Calculated | N/A |  |
| kWc | Lighting load connected to control | Site-specific | kW |  |
| Qtyb | Quantity of existing fixture | Site-specific | N/A |  |
| Qtyq | Quantity of efficient fixture | Site-specific | N/A |  |
| Wb | Wattage of existing fixture | Site-specific | W |  |
| Wq | Wattage of efficient fixture at full light output | Site-specific | W |  |
| Wlow | Wattage of the efficient fixture in low-power mode | Site-specific | W |  |
| Flow | Percentage of annual operating hours that the fixture operated in low-power mode | Site-specific, if unknown lookup in Table 3‑250 | N/A | [663][664][665][666] |
| SVGb | Percent of annual lighting energy saved by the baseline lighting control | Lookup in Table 3‑249 | N/A | [662] |
| SVGq | Percent of annual lighting energy saved by the efficient lighting control | Lookup in Table 3‑249 | N/A | [662] |
| HVACd | Secondary demand in reduced HVAC consumption resulting from decreased indoor lighting wattage | Look up in Appendix F: HVAC Interactivity Factors | N/A | [660] |
| HVACc | Secondary energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage | Look up in Appendix F: HVAC Interactivity Factors | N/A | [660] |
| HVACff | Secondary energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage | Lookup in Appendix F: HVAC Interactivity Factors | MMBtu/kWh | [669] |
| Hrs | Annual hours of operation prior to installation of controls | Site-specific, if unknown use Table 3‑244 (in Section 3.7.1) | Hours | [670] |
| 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 3‑251 | N/A | [670] |
| PDF | Gas peak day factor | Lookup in Table 3‑251 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑249 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[[168]](#footnote-170) | 0.38 |
| 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 3‑250 Low-Power Mode Factor

|  |  |
| --- | --- |
| Space Type | Flow |
| Stairwell | 0.73 |
| Corridor | 0.75 |
| Parking Garage | 0.56 |
| Parking Lot | 0.45 |

Peak Factors

Table 3‑251 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | Look up in Table 3‑244 (in Section 3.7.1) | [667] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 8 years [572].

References

1. Average HVAC interactive effects by building type derived from the NEEP Mid-Atlantic TRM 2017, NEEP, *Mid-Atlantic Technical Reference Manual*, V10, Appendix E.
2. 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
3. DNV. 2022. “X1931-4 ALC PSD Phase 2 Memo.” Connecticut Energy Efficiency Board (EEB) and Evaluation Administrators.
4. 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).
5. 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>
6. 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>
7. Pacific Gas & Electric, Application Assessment of Bi-Level LED Parking Lot Lighting, February 2009, pg. 1. <https://www.osti.gov/biblio/1218189>
8. NEEP Mid-Atlantic TRM 2018, NEEP, Mid-Atlantic Technical Reference Manual, V8. May 2018, pp. 462-463.
9. 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/>
10. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162
11. 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)

### Delamping

|  |  |
| --- | --- |
| Market | Commerical/Multifamily |
| Baseline Condition | ERET/DI |
| Baseline | Existing/Dual |
| End Use Subcategory | Lighting |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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.

* Total delamping (all lamps removed): efficient wattage = 0
* Parital delamping (not all lamps removed): efficient wattage = pre-existing wattage minus wattage of removed lamps. For replacement with efficient lamps see Section 3.7.1.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑252 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Wattsb | Total Connected load of baseline fixture | Site-specific | Watts |  |
| Wattsq | Total Connected load of delamped fixture (equal to baseline watts minus wattage of removed lamps – for replacement with efficient lamps see Section 3.7.1) | Site-specific | Watts |  |
| Hrs | Deemed average hours of use per year | Look up in Table 3‑244 (in Section 3.7.1) | Hrs/yr | [671] |
| HVACc | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [672][674] |
| HVACff | HVAC Interactive Factor for Annual Fuel Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [676] |
| HVACd | HVAC Interactive Factor for Annual Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [672][674] |
| CF | Electric coincidence factor | Look up in Table 3‑244 (in Section 3.7.1) | N/A | [671] |
| PDF | Gas peak day factor | Look up in Table 3‑253 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 3‑253 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric Coincedence (CF) | Look up in Table 3‑244 (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.

Table 3‑254 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Delamping | 16 | 5.33 | [673] |

References

1. 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).
2. Navigant, *EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs*, (2013)
3. 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>
4. DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*
5. Northeast Energy Efficiency Partnerships & KEMA, *C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum.* (2011).
6. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

### Exit Signs

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | DI |
| Baseline | Existing |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Calculation Parameters

Table 3‑255 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Wb | Actual Connected load of existing exit sign | Site-specific, if unknown look up in Table 3‑256 | kW |  |
| Wq | Actual Connected load of LED exit sign | Site-specific, if unknown look up in Table 3‑256 | kW |  |
| Hrs | Average hours of use per year | Site-specific, if unknown use 8,760 | Hours |  |
| HVACc | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [677][674] |
| HVACff | HVAC Interactive Factor for Annual Fuel Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [683] |
| HVACd | HVAC Interactive Factor for Peak Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [677][674] |
| CF | Electric coincidence factor | Look up in Table 3‑257 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑257 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑256 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 |

Peak Factors

Table 3‑257 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1.00 | [679] |
| 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 3‑258 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Exit Signs | 15 | 5 | [680] |

References

1. 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.
2. 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.
3. Efficiency Vermont Technical Reference Manual 2009-55, December 2008.
4. 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.
5. DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*
6. Northeast Energy Efficiency Partnerships & KEMA, *C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum.* (2011).
7. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 10* (2023) Appendix D, Pg 1162

### LED Sign Lighting

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Lighting |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑259 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Wb | Equipment wattage for baseline condition | Site-specific, if unknown use 46 | Watts | [684] |
| Wq | Equipment wattage for energy efficient condition | Site-specific | Watts |  |
| HVACc | HVAC interaction factor for annual electric energy consumption | 0 for Exterior and Unconditioned Spaces; otherwise see Appendix F: HVAC Interactivity Factors | N/A |  |
| HVACd | HVAC interaction factor at utility summer peak hour | 0 for Exterior and Unconditioned Spaces; otherwise see Appendix F: HVAC Interactivity Factors | N/A |  |
| HVACff | 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 | [690][691] |
| 1,000 | Conversion factor, one kilowatt equals 1,000 watts | 1,000 | N/A |  |
| CF | Electric coincidence factor | Lookup in  Table 3‑52 | N/A | [685][686][687][688][689] |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑260 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 |
| 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 3‑261 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | Lookup in  Table 3‑52 | [685][686][687][688][689] |
| 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 3‑262 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| LED Sign Lighting | 15 | 5 | [684] |

References

1. Measured average demand data. Southern California Edison, “Replace Neon Open Sign with LED Open Sign”, Workpaper SCE13LG070, Revision 2, October 2015. Pg. 10.
2. 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](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%20Accessed%20December%202018).
3. 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>
4. 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.
5. Mid-Atlantic Technical Reference Manual v8.0, <https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V7_FINAL.pdf>
6. UI and CL&P Program Savings Documentation for 2013 Program Year, United Illuminating Company, September 2012.
7. ConEd Large C&I Program Impact and Process Evaluation Report prepared by Navigant, August 2019, slide 71.
8. Time switch control – assume 6 hours per day, 365 days per year

### Indoor Horticulture LED

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | NC/TOS/DI |
| Baseline | ISP/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑263 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 |  |
| Nq | Number of energy efficient fixtures | Site-specific | fixtures |  |
| Wq | Wattage of energy efficient fixtures | Site-specific | W |  |
| PPEq | Photosynthetic photon efficacy (PPE) of qualifying equipment | Site-specific | μmol/j |  |
| PPEb | Photosynthetic photon efficacy (PPE) of baseline equipment | Lookup in Table 3‑264 | μmol/j | [693][694] [695] |
| HVACc | HVAC interactive effects for electricity consumption | Look up in Appendix F: HVAC Interactivity Factors | N/A | [695] |
| HVACd | HVAC interactive effects for electricity peak demand | Look up in Appendix F: HVAC Interactivity Factors | N/A | [695] |
| CF | Electric coincidence factor | Lookup in Table 3‑265 | N/A |  |
| PDF | Gas peak demand factor | Lookup in Table 3‑265 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑264 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 |
| Unknown | Average | 1.55 |

Peak Factors

Table 3‑265 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1 | [696] |
| 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 3‑266 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Indoor Horticulture LED | 12 | 4 | [697] |

References

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3. “LED Grow Light Buyer’s Guide.” 2016. Chilled Tech-LED Grow Lights & Spectrum Control. October 22, 2016. <https://chilledgrowlights.com/education/led_buyers_guide>
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5. 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>
6. 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/>

## Motors and Drives

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑267 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak, | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| HP | Rated horsepower of the efficient equipment | Site-specific | HP |  |
| Effq | Full-load efficiency of qualifying efficiency motor | Site-specific | N/A |  |
| Effb | Full-load efficiency of code-compliant baseline motor | Site-specific or look up in Table 3‑268 & Table 3‑269 | N/A | [698] |
| RLF | Ratio of the peak annual motor load to the maximum connected load | Site-specific, if unknown, use 0.75 | N/A | [699] |
| FLH | Full-load hours in the energy efficient case | Site-specific, if unknown look up in Table 3‑270 | Hrs | [700] |
| 0.746 | Unit conversion, kW/HP | 0.746 | kW/HP |  |
| CF | Electric coincidence factor | Look up in Table 3‑271 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑271 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑268 Baseline Efficiencies for NEMA Design A and NEMA Design B Motors[[169]](#footnote-171)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 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 3‑269 Baseline Motor Efficiencies for NEMA Design C Motors[[170]](#footnote-172)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 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 3‑270 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 |
| 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 |
| 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 3‑271 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [440] |
| 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 3‑272 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Motors | 15 | 5 | [702] |

References

1. 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>
2. U.S. DOE, Determining Electric Motor Load and Efficiency, April 2014,

<https://energy.gov/sites/prod/files/2014/04/f15/10097517.pdf>

1. Connecticut Program Savings Document, 12th Edition for 2017 Program Year, UIL Holdings Corporation and Eversource Energy Appendix 5, Hours of Use, October 2016.
2. 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. 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>

### Switched Reluctance Motors

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | NC/RF/EREP |
| Baseline | Code/Existing/Dual |
| End Use Subcategory | Motors and Drives |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

Description

A Switched Reluctance Motor (SRM) is a type of brushless DC electric motor that runs by reluctance torque. Unlike other DC motor types, power is delivered to windings in the stator rather than the rotor. This simplifies the mechanical design; power does not need to be delivered to a moving part, but requires a switching system through software control to deliver power to the different windings. Electronic devices can precisely time switch, facilitating SRM configurations. In applications on rooftop units (RTUs), the SRM is comparable or more efficient than an RTU equipped with a variable speed drive supply fan. It results in fan-energy savings and can also include cooling savings if coupled with compressor or ventilation control, compared to a baseline scenario of constant-volume, constant-ventilation operation that is typical of single-zone, packaged HVAC units. Fan energy savings come from the new integrated motor controls that allow for higher efficiency at varying loads and is achieved in all applications.

Baseline Case

The baseline equipment for this measure is a single-zone, packaged HVAC unit (with an existing functional integrated economizer) that lacks demand-controlled ventilation controls and lacks supply-fan speed control via a variable-frequency drive.

Efficient Case

The efficient equipment is a single-zone, packaged HVAC unit with a functional integrated economizer that has been fitted with a SRM supply-fan and integrated speed control.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Summer Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑273 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| HP | Fan horsepower | Site-specific | HP |  |
| hrs | Annual operating hours for fan motor | Site-specific. If unknown, look up in Appendix D: HVAC Fan and Pump Operating Hours | hrs |  |
| SFfan | Savings factor for fan[[171]](#footnote-173) | Look up in Table 3‑170 | N/A | [703], [704] |
| 0.746 | Conversion from horsepower to kW | 0.746 | kW/HP |  |
| CF | Electric coincidence factor | Look up in Table 3‑174 | N/A | [705] |
| EUL | Effective useful life | See Measure Life Section | Years | [706] |

Table 3‑274 Energy Savings Factors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Energy Savings Factor | Retrofit Type | SRM on Single Stage Compressor | SRM on Single Two Stage Compressor | SRM on Variable Speed Compressor |
| SFfan | New Construction/Early Replacement | 0.390 | 0.522 | 0.533 |

Peak Factors

Table 3‑275 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.913 | [705] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 12 years [705].

References

1. NREL, *Performance Evaluation of Three RTU Energy Efficiency Technologies*. (2020), <https://www.nrel.gov/docs/fy21osti/75551.pdf>
2. Slipstream, *Switched-Reluctance Motor Field Evaluation*. (2022), <https://turntide.com/wp-content/uploads/2022/05/SRM_final_report_03_25_2022-1.pdf>
3. *2024 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 12.0*. (2023). <https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf>
4. P. Andrada, B. Blanque, E. Martınez, J.I. Perat, J.A. Sanchez, and M. Torrent, *Environmental and life cycle cost analysis of one switched reluctance motor drive and two inverter-fed induction motor drives*. (2010), page 2, <https://www.researchgate.net/publication/309187141_Environmental_and_Life_Cycle_Cost_Analysis_of_a_Synchronous_Reluctance_Machine>

### VFD

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑276 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 | [707] |
| ηmotor | Motor efficiency at the full-rated load. | Site-specific | N/A |  |
| ESF | Energy Savings Factor | Lookup in Table 3‑277 | Fraction | [708] |
| DSF | Demand Savings Factor | Lookup in Table 3‑277 | Fraction | [708] |
| 0.746 | Conversion factor for HP to kW | 0.746 | kW/HP |  |
| CF | Electric coincidence factor | Look up in Table 3‑278 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑278 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑277 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 3‑278 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[709].

References

1. Regional Technical Forum. Proposed Standard Savings Estimation Protocol for Ultra-Premium Efficiency Motors. November 5, 2012. Appendix C, Table 6.
2. 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/>
3. California eTRM, CPUC Support Tables: Effective Useful Life and Remaining Useful Life <https://www.caetrm.com/cpuc/table/effusefullife/>

### 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 [710].

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 WidthModulation (PWM) drive or ***v***ariable Voltage Variable Frequency (VVVF) based on the baselinecondition, 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:

SCR drive or PWM drive baseline:

Annual Fuel Savings

Annual Peak Demand Savings

Motor-Generator set (M-G) baseline:

SCR drive or PWM drive baseline:

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑279 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWhPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime fuel savings | Calculated | Therms |  |
| kWhb | Energy consumption of baseline | Calculated | kWh |  |
| kWhq | Energy consumption of qualifying | Calculated | kWh |  |
| ΔkWhregen | Energy savings due to regenerative braking system | Calculated | kWh |  |
| Effb | Energy efficiency, baseline | Calculated | N/A |  |
| Effq | Energy efficiency, qualifying | Calculated | N/A |  |
| lbb | Capacity of car, baseline | Site-specific | Lbs |  |
| lbq | Capacity of car, qualifying | Site-specific | Lbs |  |
| OCWb | Overweight of counterbalance as fraction of car capacity, baseline | Site-specific | N/A |  |
| (ft/min)b | Rated top velocity of car, baseline | Site-specific | Ft/min |  |
| Hp | Horsepower of M-G set motor | Site-specific | Hp |  |
| OCWq | 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 |  |
| Effmotor,b | NEMA premium efficiency, baseline | Site-specific | N/A |  |
| Effmotor,q | NEMA premium efficiency, qualifying | Site-specific | N/A |  |
| Hrs | Annual hours of elevator operation | Site-specific, if unknown use 2,2750 | Hours | [711] |
| Effdrive,b | Efficiency of drive, baseline | Site-specific, if unknown use defaults: SCR6 = 0.85 SCR12 = 0.90 PWM = 0.94 | N/A | [712] |
| Effdrive,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 | [712] |
| Effgear,b | Efficiency of gear system, baseline | Geared system: 0.85 Gearless system: 1.0 | N/A | [712] |
| Effgear,q | Efficiency of gear system, qualifying | Geared system: 0.85 Gearless system: 1.0 | N/A | [712] |
| RegenSF | Savings factor for regererative braking system | Regenerative braking: 1 No regenerative breaking: 0 | N/A | [710] |
| LFavg | Average load factor | 0.35 | N/A | [713] |
| Effhoist | Efficiency of elevator hoise system | 0.9 | N/A | [711] |
| LFmotor,idle | M-G set motor load factor in idling mode | 0.11 | N/A | [591] |
| Fidle | 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 | [714] |
| LFmotor,run | M-G set motor load factor when loaded, assumed value to reflect that motors do not typically fun at 100% of rated power | 0.9 | N/A | [710] |
| LFpeak | Peak load factor | 0.75 | N/A | [713] |
| Effregen | Efficiency of regenerative braking system | 0.5 | N/A | [710] |
| Fregen | Regenerative breaking factor; used account for fraction of run hours regenerative braking produces energy savings | 0.5 | N/A | [715] |
| 8,760 | Hours in a year | 8,760 | Hours |  |
| 33,000 | Conversion factor | 33,000 | (ft-lb/min)/hp |  |
| 0.746 | Conversion factor | 0.746 | kW/hp |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Peak Factors

Table 3‑280 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. | [591] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 15 years [716].

References

1. New York TRM v10, Elevator Modernization, pg. 887. <https://dps.ny.gov/technical-resource-manual-trm>
2. The Vertical Transportation Handbook, 4th Edition , by George R. Strakosch and Robert S. Caporale, Table 4.2, Table 4.3, Chart 4.2.
3. International Association of Elevator Consultants, Presentation in New York City, May 2011, Slide 11.
4. ISO 25745-2:2015: Energy Performance of Lifts, Escalators and Moving Walks -- Part 2: Energy Calculation and Classification for Lifts (elevators).
5. Actual idling time is based on specific site operating conditions. A value of 70% has been assumed based on a reasonable and conservative approach.
6. Baldor Motors and Drives, Elevator Application Guide, pg. 3-6.
7. Assumes same EUL as VFD measure, source DEER 2014.

## Plug Load

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑281 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr | [717] |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ESAV | Energy Savings per unit | Look up in Table 3‑282 | kWh/unit |  |
| DSAV | Peak Demand Savings per unit | Look up in Table 3‑282 | 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 | [718] |

To determine savings, the per unit estimate in Table 3‑282 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 [717] and assumes the absence of an enabled network power management as the baseline condition.

Table 3‑282 Network Power Controls, Per Unit Summary Table

|  |  |  |  |
| --- | --- | --- | --- |
| Measure | Unit | Energy Savings  () | Peak Demand  Savings () |
| 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[[172]](#footnote-174) | 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 [718].

References

1. ENERGYSTAR Low Carbon IT Savings Calculator: <https://www.energystar.gov/sites/default/files/asset/document/LowCarbonITSavingsCalc.xlsx>
2. Computers and peripheral equipment are considered 5-year property. 2016 IRS Publication 946. <https://www.irs.gov/pub/irs-prior/p946--2016.pdf>.

### Office Equipment

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS |
| Baseline | ISP |
| End Use Subcategory | Electronics |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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 [719].

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 [720] and used in a commercial setting.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑283 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ESF | Energy savings factor | Look up in Table 3‑284 | kWh/yr | [719] |
| DSF | Electric Demand savings factor | Look up in Table 3‑284 | kW | [719] |
| HVACe | HVAC Interactive Factor for Annual Energy Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [721][722] |
| HVACd | HVAC Interactive Factor for Peak Demand Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [721][722] |
| HVACg | HVAC Interactive Factor for Annual Fuel Savings | Look up in Appendix F: HVAC Interactivity Factors | N/A | [723] |
| ΔkWPeak | Peak Demand Savings | Look up in Table 3‑284 | kW | [719] |
| CF | Electric coincidence factor | Look up in Table 3‑285 | N/A |  |
| PDF | Natural gas peak day factor (PDF) | Look up in Table 3‑285 | N/A |  |
| EUL | Effective useful life of new unit | See Measure Life Section | Years |  |

Table 3‑284 Office Equipment Energy and Demand Savings Factors per Unit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Measure | | ESF (kWh) | DSF (kW) | Source |
| **Computer (Desktop)** | | 124 | 0.0161 | [719] |
| **Computer (Laptop)** | | 37 | 0.0030 | [719] |
| **Fax Machine (laser)** | | 16 | 0.0022 | [719] |
| **Copier (monochrome)** | ≤ 5images/min | 37 | 0.0050 | [719] |
| 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 | [719] |
| 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 | [719] |
| **Multifunction Device (laser, monochrome)** | ≤ 5 images/min | 57 | 0.0077 | [719] |
| 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 | [719] |
| **Monitor** | | 8 | 0.0032 | [719] |

Peak Factors

Table 3‑285 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 3‑286 Measure Life [719]

|  |  |
| --- | --- |
| Equipment | Measure Life |
| Computer | 4 years |
| Monitor | 4 years |
| Fax | 4 years |
| Printer | 5 years |
| Copier | 6 years |
| Multifunction Device | 6 years |

References

1. 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 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.
2. ENERGY STAR Product Specifications & Partner Commitments Search, <https://www.energystar.gov/products/spec>
3. Navigant, EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs, (2013)
4. DNV KEMA (2013). Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory
5. Northeast Energy Efficiency Partnerships & KEMA, C&I Lighting Load Shape Project FINAL Report - Prepared for the Regional Evaluation, Measurement and Verification Forum. (2011).

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑287 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | 0 | kW | [726] |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Units | Number of measures installed under the program | Site-specific | N/A |  |
| ΔkWwkday | Average power reduction during weekday off hours | 0.0315 | kW | [725][726] |
| Hrswkday | Total hours during the work week (Monday 7:30 AM to Friday 5:30 PM) | 106 | Hrs |  |
| Hrswkday-open | Hours the office is open during the work week | Site-specific. If unknown, assume 50 | Hrs |  |
| ΔkWwkend | Average power reduction during weekend off hours | 0.0067 | kW | [725][726] |
| Hrswkend | Total hours during the weekend (Friday 5:30 PM to Monday 7:30 AM) | 62 | Hrs |  |
| Hrswkend-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 3‑288 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 [725].

References

1. 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>.
2. David Rogers, Power Smart Engineering, "Smart Strip Electrical Savings and Usability," October 2008.
3. *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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑289 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Size | Size of UPS in rated output power, kW | Site-specific | kW |  |
| EffAVGbase | Efficiency of existing UPS | Site-specific, if unknown look up in  Table 3‑290 | W | [727] |
| EffAVGee | Efficiency of new ENERGY STAR UPS | Site-specific, if unknown look up in Table 3‑291 | W or kW | [728] |
| EMOD | An allowance of 0.004 for Modular UPSs applicable in the commercial 1500 – 10,000 W range | 0.004 | N/A | [728] |
| EFLH | Equivalent Full Load Hours | Look up in Table 3‑292 | hours | [729] |
| CF | Electric coincidence factor | Look up in Table 3‑293 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑293 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [730] |

Table 3‑290 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 × 10-6 × P² + 7.17×10-4 × P + 0.862 |
| 300 W < P ≤ 700 W | -7.85 × 10-8 × P² + 1.01 × 10-4 × P + 0.946 |
| P > 700 W | -7.23 × 10-9 × P² + 7.52 × 10-6 × P + 0.977 |
| Voltage Independent (VI) | P ≤ 300 W | -1.20 × 10-6 × P² + 7.19 × 10-4 × P + 0.863 |
| 300 W < P ≤ 700 W | -7.67 × 10-8 × P² + 1.05 × 10-4 × P + 0.947 |
| P > 700 W | -4.62 × 10-9 × P² + 8.54 × 10-6 × P + 0.979 |
| Voltage and Frequency Independent (VFI) | P ≤ 300 W | -3.13 × 10-6 × P² + 1.96 × 10-3 × P + 0.543 |
| 300 W < P ≤ 700 W | -2.60 × 10-7 × P² + 3.65 × 10-4 × P + 0.764 |
| P > 700 W | -1.70 × 10-8 × P² + 3.85 × 10-5 × P + 0.876 |

Table 3‑291 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 × 10-5 × P + 0.962 |
| 350 W < P ≤ 1.5 kW | 0.982 |
| 1.5 W < P ≤ 10 kW | 0.981 - EMOD |
| P > 10 kW | 0.97 |
| Voltage Independent (VI) | P ≤ 350 W | 5.71 × 10-5 × P + 0.964 |
| 350 W < P ≤ 1.5 kW | 0.984 |
| 1.5 kW < P ≤ 10 kW | 0.980 - EMOD |
| P > 10 kW | 0.940 |
| Voltage and Frequency Independent (VFI) | P ≤ 350 W | 0.011 × ln(P) + 0.824 |
| 350 W < P ≤ 1.5 kW | 0.011 × ln(P) + 0.824 |
| 1.5 W < P ≤ 10 kW | 0.0145 × ln(P) + 0.8 - EMOD |
| P > 10 kW | 0.0058 × ln(P) + 0.886 |

Table 3‑292 Equivalent Full Load Hours

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Rated Output Power (P) in Watts | UPS Product Class | Time spent at specified proportion of reference test load (t) | | | | EFLH[[173]](#footnote-175) |
| **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 3‑293 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 [730].

References

1. 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>
2. 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>
3. Calculation and inputs provided in ENERGY STAR Uninterruptible Power Supplies Final Version 2.0 Specification.
4. 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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑294 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWhb | Energy usage of baseline vending machine | Site Specific, if unknown calculate using Table 3‑295 | kWh/day | [731] |
| kWhq | Energy usage of ENERGY STAR vending machine | Site Specific, if unknown calculate using Table 3‑295 | kWh/day | [732] |
| V | Refrigerated Volume | Site Specific, if unknown use 23.62 | Ft3 | [733] |
| Days | Days of vending machine operation per year | 365.25 | days | [734] |
| CF | Electric coincidence factor | Look up in Table 3‑296 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑296 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [733] |

Table 3‑295 Energy Consumption Default Values

|  |  |  |
| --- | --- | --- |
| Equipment Class | Baseline (kWhb) kWh/day | Energy Star (kWhq) 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 3‑296 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 [733].

References

1. 10 CFR §431.296 - Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines.
2. ENERGY STAR® Version 4.0 requirements for maximum daily energy consumption.
3. 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>.
4. 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/>

### 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

Non-Refrigerated Vending Machine

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑297 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWunit | Vending machine power (kW) | Look up in Table 3‑298 | kW | [735][737] |
| hrsoff | 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 |  |
| Fctrl | 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 | [736] |
| CF | Electric coincidence factor | Look up in Table 3‑299 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑299 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑298 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 3‑299 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 [738].

References

1. *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>
2. 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>
3. Southern California Edison, *Workpaper SCE17CS005, Revision 1, Beverage Merchandise Controller*, July 23, 2018. <http://deeresources.net/workpapers>
4. 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>.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑300 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| 403 | Deemed Annual Energy Savings | 403 | kWh/yr | [739] |
| NEVSE | Number of EVSE | N/A | N/A | [739] |
| CF | Electric coincidence factor | Look up in Table 3‑301 | N/A | [739] |
| PDF | Gas peak demand factor | Look up in Table 3‑301 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [739] |

Peak Factors

Table 3‑301 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 75% | [739] |
| 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 [739].

References

1. 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>

### Lithium Ion Fork Truck Batteries

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | TOS/RF |
| Baseline | ISP/Existing |
| End Use Subcategory | N/A |
| Measure Last Reviewed | January 2025 |
| Changes Since Last Version | * New Measure |

Description

Based on the Illinois TRM. [740] This measure applies to electric fork trucks used in commercial, industrial, and warehouse environments. Electric fork trucks with lithium ion battery systems are more efficient than electric fork trucks with traditional lead acid battery systems because the lithium ion batteries have lower internal resistance. This allows the batteries to transfer power faster, reduces waste heat, and reduces standby losses.

Electric fork trucks can be purchased with lithium ion battery systems or an existing electric fork truck can be retrofitted to use a lithium ion battery system. An electric fork truck can be converted to a lithium ion battery system by removing the lead acid battery and installing a battery case that includes a series of lithium ion batteries and the appropriate ballast to meet weight and balance specifications for the fork truck. The lithium ion battery case is a one-for-one equivalent replacement of the lead acid battery in respect to capacity, shape, and weight. The fork truck may require a new charger to work with the new lithium ion battery system. Electric fork trucks can also replace propane or diesel powered fork truck in a one to one scenario. Where a facility normally operates a fleet of fossilfueled fork trucks a fossil-fuel baseline should be considered for any additional fork trucks that might be purchased beyond the current quantity of trucks operating at the facility.

Baseline Case

Class I, Class II, or Class III fork trucks that are powered by lead acid batteries or fossil-fuels such as propane or diesel with minimum 8-hour shift operation five days per week.

Efficient Case

Class I, Class II, or Class III fork trucks that are powered by lithium ion batteries with minimum 8-hour shift operationfive days per week.

Annual Energy Savings Algorithms

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑302 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Look up in Table 3‑303 | kWh/yr | [740] |
| ΔTherms | Annual fuel savings | Look up in Table 3‑303 | Therms/yr | [740] |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |

Table 3‑303 Lithium Ion Fork Truck Battery Savings

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Facility Operation (assume 1-shift if unknown) | Lead Acid Baseline | Diesel Baseline | | Propane Baseline | |
| **ΔkWh** | **ΔTherms** | **ΔkWh** | **ΔTherms** | **ΔkWh** |
| 1-shift (8 hrs/day – 5 days/week) | 11,707 | 1,740 | 51,079 | 1,750 | 51,427 |
| 2-shift (16 hrs/day – 5 days/week) | 23,414 | 3,490 | 102,158 | 3,510 | 102,855 |
| 3-shift (24 hrs/day – 5 days/week) | 35,121 | 5,230 | 153,238 | 5,260 | 154,282 |
| 4-shift (24 hrs/day – 7 days/week) | 49,169 | 7,320 | 214,533 | 7,370 | 215,995 |

Peak Factors

Table 3‑304 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. [741]

References

1. 2025 IL TRM v.13 Vol. 2, pg. 1005: <https://www.ilsag.info/wpcontent/uploads/ILTRM_Effective_010125_v13.0_Vol_2_C_and_I_09202024_FINAL.pdf>
2. Lifetime of measure assumed to be limited by the lifetime of the lithium ion charger, per 2025 IL TRM v.13 Vol. 2

## Refrigeration

### Energy Efficient Glass Doors on Vertical Open Refrigerated Cases

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Refrigeration |
| Measure Last Reviewed | November 2022 |
| Changes Since Last Version |  |

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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑305 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | 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 |  |
| ΔkWh/ft | Annual electric energy savings per foot of door opening | Look up in Table 3‑306 | kWh/yr-ft | [742] |
| COPref | 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 |  |
| COPHVAC | Coefficient of performance of heating, ventilation, and cooling equipment | Site-specific. If unknown, look up in Table 3‑307 | N/A | [743] |
| Eff | Fossil fuel-fired heating system efficiency | Site-specific[[174]](#footnote-176). If unknown, use 0.8 |  | [744] |
| Hrscooling | Cooling HVAC load hours | Site-specific | Hours |  |
| Hrsheating | 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 3‑308 | N/A |  |
| PDF | Peak day factor | Look up in Table 3‑308 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 3‑306 Annual electric energy savings per foot of door opening

|  |  |
| --- | --- |
| Door Type | ΔkWh/ft[[175]](#footnote-177) |
| High-Efficiency Doors on Cooler | 477 |
| High-Efficiency Doors on Freezer | 747 |
| Standard Doors on Cooler | 183 |
| Standard Doors on Freezer | 392 |

Table 3‑307 Coefficient of performance of HVAC systems

|  |  |
| --- | --- |
| Location[[176]](#footnote-178) | COPHVAC |
| Grocery Store | 2.93 |
| Other | 3.57 |

Peak Factors

Table 3‑308 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 1.0[[177]](#footnote-179) | [745] |
| 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 3‑309 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Case Doors | 4 | 1.3 | [746] |

References

1. 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>
2. 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>
3. 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>
4. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, Version 10, January 2023
5. 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>.

### Door Closer

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Controls |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

Description

This 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 perimeter 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑310 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Look up in Table 3‑311 | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Look up in Table 3‑311 | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| CF | Electric coincidence factor | Lookup in Table 3‑311 | N/A | [1] |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑311 Deemed savings for Walk-in Freezer and Coolers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Location | ΔkWhcooler | ΔkWcooler | ΔkWhfreezer | ΔkWfreezer |
| Northern | 2,951 | 0.93 | 8,590 | 1.46 |
| Central | 2,894 | 0.91 | 8,425 | 1.43 |
| Pine barrens | 2,737 | 0.86 | 7,969 | 1.35 |
| Southwest | 2,864 | 0.90 | 8,338 | 1.42 |
| Coastal | 2,539 | 0.80 | 7,392 | 1.26 |
| **Statewide Average** | 2,825 | **0.89** | 8,225 | **1.40** |

Peak Factors

Peak demand is accounted for in the deemed savings values presented in Table 3‑311.

Measure Life

The effective useful life (EUL) is 8 years [3].

References

1. Illinois Statewide Technical Reference Manual for Energy Efficiency , Volume 2: Commercial and Industrial Measures, v12.0, 2024, page 794, [https://www.ilsag.info/wp-content/uploads/IL-TRM\_Effective\_010124\_v12.0\_Vol\_2\_C\_and\_I.pdf](https://www.ilsag.info/wp-content/uploads/IL-TRM_Effective_010124_v12.0_Vol_2_C_and_I_09222023_FINAL_clean.pdf)
2. Southern California Edison, Commercial Refrigeration: Auto-Closer for Refrigerated Storage Door (SWCR005-02), California eTRM, November 16, 2020 ). <http://www.deeresources.net/workpapers>.
3. "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>

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑312 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ∆kWh/Door | Annual Energy Savings per Foot of gasket | Lookup in Table 3‑313 | kWh | [4][5] |
| ∆kW/Door | Demand Savings per Foot of gasket | Lookup in Table 3‑313 | kW | [4][5] |
| Doors | Total number of gasket doors replaced | Site-specific | N/A | [4][5] |
| CF | Electric coincidence factor | Lookup in Table 3‑314 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years | [6] |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 3‑313 Door Gasket Savings Per Foot of Gasket for Walk-in and Reach-in Coolers and Freezers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type | Coolers | | Freezers | |
| **∆kW/door** | **∆kWh/door** | **∆kW/door** | **∆kWh/door** |
| Reach-in | 0.032 | 248 | 0.032 | 243 |
| Walk-in | 0.027 | 204 | 0.045 | 347 |

Peak Factors

Table 3‑314 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 3‑315 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Door Gaskets | 4 | 1.3 | [6] |

References

1. Database for UES Measures, Regional Technical Forum. Door Gasket Replacement, version 1.5. December 2016. <https://rtf.nwcouncil.org/measure/door-gasket-replacement>
2. Pennsylvania TRM 2021, August 2019 available at <https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/>
3. 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>.

### Night Covers

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Refrigeration |
| Measure Last Reviewed | November 2022 |
| Changes Since Last Version |  |

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 3‑317 and Table 3‑318 [7]. 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* 3‑317 *and Table* 3‑318 *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 [8].

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithm

Lifetime Fuel Energy Savings

Calculation Parameters

3‑316 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| TDA[[178]](#footnote-180) | Total Display Area of the open case | Site-specific | Ft2 |  |
| units | Number night covers installed | Site-specific | N/A |  |
| TDEC | Total Daily Energy Consumption | Look up in Table 3‑317, Table 3‑318 | kWh/day | [7] |
| ESF | Energy Savings Factor | 0.054 | N/A | [8] |
| 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 3‑317 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 3‑318 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 |
| 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 3‑319 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 3‑320 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Night Covers | 5 | 1.67 | [9] |

References

1. 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](https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431" \l "431.66)
2. 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>
3. DEER 2014 EUL ID: GrocDisp-DispCvrs.

### Strip Curtains

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Load Reduction |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation ParametersTable 3‑321 Calculation Parameters

Table 3‑322 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ∆kWh/ft2 | Average annual kWh savings per square foot of insulation barrier | Look up in  Table 3‑323 | kWh/ft2 | [10] |
| A | Doorway area | Site-specific, if unknown look up in Table 3‑324 | ft2 | [10] |
| Hrs | Annual hours of operation | Site-specific, if unknown use 8766 | Hours |  |
| CF | Electric coincidence factor | Look up in Table 3‑325 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑325 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 3‑323 Default Annual Energy Savings for Strip Curtains per Square Foot

|  |  |  |
| --- | --- | --- |
| Type | Energy Savings for no pre-exisitng curtains, | Energy Savings for pre-exisitng curtains, |
| 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 3‑324 Doorway Area Assumptions

|  |  |
| --- | --- |
| Type | Doorway Area, ft2 |
| Grocery - Cooler | 22.5 |
| Grocery - Freezer | 22.5 |
| Convenience Store - Cooler | 22.5 |
| Convenience Store - Freezer | 22.5 |
| Restaurant - Cooler | 22.5 |
| Restaurant - Freezer | 22.5 |
| Refrigerated Warehouse - Cooler | 120 |

Peak Factors

Table 3‑325 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 3‑326 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Strip Curtains | 4 | 1.33 | [11] |

References

1. IL TRM v10, pg 650.
2. 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. JCPL PY2 Evaluation Report

### Anti-sweat Heat Control

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Refrigeration |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑327 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWd | Connected load kW per connected door | Site-specific, if unknown use 0.13 | kW/door | [13] |
| N | Number of doors | Site-specific | N/A |  |
| %ONb | Effective runtime of the uncontrolled ASDH | Site-specific, if unknown use 90.7% | N/A | [13] |
| %ONq | Effective runtime of the controlled ASDH | Look up in Table 3‑328 | N/A | [13] |
| IFe | Interactive effects factor for energy to account for cooling savings from offset refrigeration load | Look up in Table 3‑329 | N/A | [13] |
| CF | Electric coincidence factor | Look up in Table 3‑330 Coincidence Factors | N/A | [13] |
| Hrs | Hours of operation | 8,760 | Hrs |  |
| EUL | Effective useful life | See Measure Life Section | Years | [14] |

Table 3‑328 Effective run time of controlled ASDH

|  |  |  |
| --- | --- | --- |
| Control Type | Value | Ref |
| ON/OFF control style | 58.9% | [13] |
| Micropulse control style | 42.8% | [13] |
| Unknown control style | 45.6% | [13] |

Table 3‑329 Interactive effects factor for energy[[179]](#footnote-181)

|  |  |  |
| --- | --- | --- |
| System Type | IFeValue | Ref |
| Cooler or Refrigerator | 1.26 | [13] |
| Freezer | 1.51 | [13] |

Coincidence Factor

Table 3‑330 Coincidence Factors[[180]](#footnote-182)

|  |  |  |
| --- | --- | --- |
| Control Type | CF Value | Ref |
| ON/OFF control style | 0.32 | [13] |
| Micropulse control style | 0.45 | [13] |
| Unknown control style | 0.44 | [13] |

Measure Life

The effective useful life (EUL) is 12 years [14].

References

1. 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>
2. California eTRM, CPUC Support Tables: Effective Useful Life and Remaining Useful Life <https://www.caetrm.com/cpuc/table/effusefullife/>

### Defrost Controls

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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 the defrost of evaporator coils when unnecessary, reducing annual energy consumption. The estimates for savings take into account savings from the 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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑331 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔkWhDefrost | Energy savings resulting from an increase in operating efficiency due to the addition of electronic defrost controls. | Calculated | kWh |  |
| ΔkWhHeat | Energy savings due to reduced heat from the reduced number of defrost cycles | Calculated | kWh |  |
| kWDefrost | 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[[181]](#footnote-183) | Hrs/yr | [17] |
| DRF | Defrost reduction factor- percent reduction in defrosts required per year | 35% |  | [15] |
| EffRS | Efficiency of typical refrigeration system | From Application, if unknown 3.35 (cooler), 1.88 (freezer) | kW/ton | [18] |
| 0.28 | Conversion constant | 0.28 | ton/kW |  |
| CF | Electric coincidence factor | Look up in Table 3‑332 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑332 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 3‑332 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 [27].

References

1. 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
2. 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
3. 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>.
4. 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>

### LED Case Lighting

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑333 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Wb | 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 | [23] |
| Wq | 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 | [19] |
| Effcomp | Compressor efficiency | Site-specific, if unknown look up in Table 3‑334 | kW/ton | [20] |
| 0.284 | Conversion factor from kW to tons of refrigeration | 0.284 | Tons/kW |  |
| CF | Electric coincidence factor | Look up in Table 3‑335 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑335 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life of existing unit | See Measure Life Section | Years |  |

Table 3‑334 Compressor Efficiency

|  |  |
| --- | --- |
| Case Type | Effcomp |
| Cooler | 1.00 |
| Freezer | 1.92 |

Peak Factors

Table 3‑335 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.92 | [21] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is smaller of the measure EUL (16 years [22]) and the case RUL.

References

1. 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.
2. 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.
3. Pennsylvania PUC, Technical Reference Manual, June 2016, p. 258.
4. DEER 2014 EUL ID: GrocDisp-FixtLtg-LED
5. Pacific Gas & Electric. May 2007. LED Refrigeration Case Lighting Workpaper 053007 rev1. Values normalized on a per linear foot basis.

### Refrigerated Case Light Occupancy Sensors

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

There are no peak demand savings associated, as the savings are assumed to occur off-peak.

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑336 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 | [24] |
| IFe | Interactive effects factor for energy to account for colling savings from offset refrigeration load | Lookup in Table 3‑337 | N/A | [25] |
| RRF | Runtime reduction factor | Lookup in Table 3‑338 | N/A | [26] |
| 1,000 | Conversion factor | 1,000 | W/kW |  |
| CF | Electric coincidence factor | Lookup in Table 3‑339 | N/A |  |
| PDF | Gas peak day factor | Lookup in Table 3‑339 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑337 Interactive Effects Factor

|  |  |
| --- | --- |
| Refrigerator and Cooler | Freezer |
| 0.29 | 0.50 |

Table 3‑338 Runtime Reduction Factor

|  |  |
| --- | --- |
| 24 Hour Facility | 18 Hour Facility |
| 0.39 | 0.29 |

Peak Factors

Table 3‑339 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 3‑340 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Refrigeratred Case Lighting | 8 | 2.66 | [27] |

References

1. 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>
2. 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>
3. “ComGroceryDisplayCaseMotionSensors\_v3\_3.Xlsm | Powered by Box.” n.d. Nwcouncil.app.box.com. Accessed January 20, 2023. <https://nwcouncil.app.box.com/s/brl01usbhxvtrjbp0i2xcqk016lndfd1>
4. 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>

### Evaporator Fan EC Motor

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

If motor power is unknown, calculate using the algorithms below:

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑341 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| kWb | Input wattage of the baseline motor | Site-specific, if unknown, calculated from motor HP | kW |  |
| kWq | Input wattage of the efficient motor | Site-specific, if unknown, calculated from motor HP | kW |  |
| Funcontrolled | Effective runtime fraction of the uncontrolled motor | Site-specific, if unknown, use 0.978 | N/A | [28] |
| HPb | Rated horsepower of the baseline motor | Site-specific, if unknown use HPq | HP |  |
| HPq | Rated horsepower of the efficient motor | Site-specific | HP |  |
| LF | Load factor | Site-specific[[182]](#footnote-184), if unknown, use 0.9 |  | [30] |
| IFe | Interactive effects factor for energy to account for cooling savings from offset refrigeration load | Look up in Table 3‑342 | N/A | [28] |
| 8,760 | Annual operating hours of Evaporator Fan | 8,760 | hours |  |
| 0.746 | Unit conversion, kW/HP | 0.746 | kW/HP |  |
| Effb | Efficiency of the baseline motor | SP: 30%  PSC: 60% | N/A | [29] |
| Effq | Efficiency of the qualifying motor | ECM: 70%  PMS: 73% | N/A | [29] |
| CF | Electric coincidence factor | Look up in Table 3‑343 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑343 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑342 Interactive Factor for Energy

|  |  |
| --- | --- |
| Equipment Type | IFe Value |
| SP Base, Cooler | 0.38 |
| PSC Base, Cooler | 0.19 |
| SP Base, Freezer | 0.76 |
| PSC Base, Freezer | 0.38 |

Peak Factors

Table 3‑343 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 [31].

References

1. Cadmus, *Commercial Refrigeration Loadshape Project* (2015). <https://cadmusgroup.com/wp-content/uploads/2016/02/NEEP-CRL_Report_FINAL_clean.pdf>
2. 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>
3. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential Multifamily, and Commercial/Industrial Measures. Version 6*. (April 16, 2018)
4. 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

### Evaporator Fan Controller

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑344 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | 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 | [34] |
| LF | Load Factor - Ratio between the actual load and the rated load. | Site-specific, if unknown use 0.9 | N/A | [34] |
| HP | Horsepower of SP, PSC or ECM motor | Site-specific | HP |  |
| ⴄ | Motor efficiency of the SP, PSC or ECM motor | SP: 30%  PSC: 60%  ECM: 70% |  | [35] |
| %ONb | Effective runtime of the uncontrolled motor | Site-specific, if unknown use 97.8% | N/A | [32] |
| %ONq | Effective runtime of the controlled motor | Site-specific, if unknown look up in Table 3‑345 | N/A | [32] |
| IFe | Interactive effects factor for energy to account for cooling savings from offset refrigeration load | Look up in Table 3‑346 | N/A | [32] |
| CF | Electric coincidence factor | Look up in Table 3‑347 | N/A | [32] |
| Hrs | Hours of operation | 8,760 | Hrs |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑345 Effective run time of controlled motors

|  |  |  |
| --- | --- | --- |
| Control Type | Value | Ref |
| ON/OFF style controls | 63.6% | [32] |
| Multi-speed style controls | 69.2% | [32] |
| Unknown | 66.5% | [32] |

Table 3‑346 Interactive Effects Factor for Energy[[183]](#footnote-185)

|  |  |  |
| --- | --- | --- |
| System Type | IFeValue | Ref |
| Cooler or Refrigerator | 1.38 | [32] |
| Freezer | 1.76 | [32] |

Coincidence Factor

Table 3‑347 Coincidence Factors[[184]](#footnote-186)

|  |  |  |
| --- | --- | --- |
| Control Type | CF Value | Ref |
| ON/OFF control style | 0.087 | [32] |
| Micropulse control style | 0.102 | [32] |
| Unknown control style | 0.094 | [32] |

Measure Life

The effective useful life (EUL) is 16 years [33].

References

1. 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>
2. 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. DNV KEMA (2013). *Impact Evaluation of 2010 Prescriptive Lighting Installations. Prepared for Massachusetts Energy Efficiency Program Administrators and Massachusetts Energy Efficiency Advisory*
4. 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>

### 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

If the refrigeration system is rated in tonnage:

Annual Fuel Savings

Peak Demand Savings

0

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑348 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| HPcompressor | 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 3‑349 | kWh/HP | [36][39] |
| COP | Coefficient of Performance | Look up in Table 3‑350 | N/A | [36][38] |
| 4.715 | Unit Conversion, HP/ton | 4.715 | HP/ton |  |
| CF | Electric coincidence factor | Look up in Table 3‑351 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑351 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Annual Savings per HP

Table 3‑349 Annual Savings per HP

|  |  |
| --- | --- |
| System Type/Size | kWh/hp |
| Unitary Condenser, Low Temp, 0-3 hp | 252.03 |
| 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 3‑350 COP for refrigeration equipment

|  |  |  |  |
| --- | --- | --- | --- |
| System Type | Freezer (Low Temp) | Refrigerator (Medium Temp) | Ref |
| Unitary Condenser | 1.4 | 2.6 | [36] |
| Remote Condenser | 1.88 | 3.35 | [38] |

Peak Factors

Table 3‑351 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 15 years [37] or one-third of the EUL of the host equipment.

References

1. 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.

1. 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>
2. DNV. 2022. “X1931-5 PSD Commercial Refrigeration Efficiency Update Study.” Connecticut Energy Efficiency Board.
3. 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>

### VFD Compressor

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Refrigeration |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑352 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| HPcompressor | Rated horsepower per compressor | Site-specific | hp |  |
| ESvalue | Energy savings value | 1,696 | kWh/ton | [40] |
| DSvalue | Demand savings value | 0.22 | Kw/ton | [40] |
| COP | Coefficient of performance | Site-specific, if unknown look up in Table 3‑353 | N/A | [41] |
| 0.212 | Conversion factor from HP to ton | 0.212 | Ton/hp |  |
| CF | Electric coincidence factor | Look up in Table 3‑354 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑354 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑353 COP for refrigeration equipment

|  |  |
| --- | --- |
| Equipment | COP |
| Coolers | 3.35 |
| Freezers | 1.88 |

Peak Factors

Table 3‑354 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 15 years[42].

References

1. 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>
2. 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>
3. California eTRM, CPUC Support Tables: Effective Useful Life and Remaining Useful Life <https://www.caetrm.com/cpuc/table/effusefullife/>

## Water Heating

### 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

Where,

Annual Fuel Savings

Peak Demand Savings

Where,

For baseline of large electric storage type water heaters (> 12kW and > 20 gallons):

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):

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑355 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔTmain | Average temperature difference between water heater set point temperature and the supply water temperature in water main | Calculated | °F |  |
| ΔTamb | Average temperature difference between water heater set point temperature and the surrounding ambient air temperature | Calculated | °F |  |
| UAb | Overall heat loss coefficient of the baseline condition | Calculated | Btu/h-°F |  |
| GPD | Gallons per day | Site Specific, if unknown look up in Table 3‑356 | Gal/day | [53][54][55][56] |
| UAq | Overall heat loss coefficient of the energy efficient measure | Site-specific | Btu/h-°F |  |
| SLb | Standby loss of baseline unit | Code baseline: calculated  Existing baseline: site-specific, calculated if unknown | kBtu/hr |  |
| SLq | Standby loss of efficient unit from AHRI rating | Site-specific | kBtu/hr |  |
| Tset | Water heater set point temperature | Site-specific, if unknown use 125 | °F | [47] |
| Et,b | Thermal efficiency of the baseline condition | Site-specific. If unknown, look up in Table 3‑357 | N/A | [257][398] |
| Et,q | Thermal efficiency of the energy efficient condition | Site-specific | N/A |  |
|  | Baseline tank volume, equal to the storage capacity of the efficient equipment | Site-specific | gal |  |
|  | Baseline input capacity, equal to the input capacity of the efficient equipment | Site-specific | Btu/hr |  |
| Tmain | Supply water temperature in water main[[185]](#footnote-187) | 60 | °F | [251] |
| Tamb | Surrounding ambient air temperature | 70 | °F | [48] |
| 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 3‑358 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑358 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |
| RUL | Remaining useful life | See Measure Life Section | Years |  |

Table 3‑356 GPD[[186]](#footnote-188)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Building Type | GPD | Rate | Notes/Assumptions | Source | REf |
| Assembly | 239 | 7.02 GPD per 1,000 SF | Assumes 34,000 SF | EIA926: Public Assembly | [43] |
| Auto Repair | 25 | 4.89 GPD per 1,000 SF | Assumes 5,150 SF | EIA: Other | [43] |
| Big Box Retail | 448 | 3.43 GPD per 1,000 SF | Assumes 130,500 SF | EIA: Mercantile | [43] |
| Community College | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL927: School with Showers | [44] |
| Dormitory | 8,600 | 17.2 GPD per resident | Assumes 500 residents | Water Research Foundation928 | [45] |
| Elementary School | 250 | 0.5 GPD per student | Assumes 500 students | NREL: School | [44] |
| Fast Food Restaurant | 500 | 500 GPD per restaurant |  | FSTC929: Quick Service | [46] |
| Full-Service Restaurant | 2,500 | 2,500 GPD per restaurant |  | FSTC: Full Service | [46] |
| Grocery | 172 | 3.43 GPD per 1,000 SF | Assumes, 50,000 SF | EIA: Mercantile | [43] |
| High School | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL: School with Showers | [44] |
| Hospital | 16,938 | 54.42 GPD per 1,000 SF | Assumes 250,000 SF | EIA: Health Care, Inpatient | [43] |
| Hotel | 9,104 | 45.52 GPD per 1,000 SF | Assumes 200,000 SF | EIA: Lodging | [43] |
| Large Office | 550 | 1.1 GPD per person | Assumes 500 people | NREL: Office | [44] |
| Large Retail | 446 | 3.43 GPD per 1,000 SF | Assumes 130,000 SF | EIA: Mercantile | [43] |
| Light Industrial | 489 | 4.89 GPD per 1,000 SF | Assumes 100,000 SF | EIA: Other | [43] |
| Motel | 1,366 | 45.52 GPD per 1,000 SF | Assumes 30,000 SF | EIA: Lodging | [43] |
| Multifamily High-Rise | 4,600 | 46 GPD per unit | Assumes 100 units | Water Research Foundation | [45] |
| Multifamily Low-Rise | 552 | 46 GPD per unit | Assumes 12 units | Water Research Foundation | [45] |
| Refrigerated Warehouse | 86 | 0.93 GPD per 1,000 SF | Assumes 92,000 SF | EIA: Warehouse and Storage | [43] |
| Religious | 77 | 7.02 GPD per 1,000 SF | Assumes 11,000 SF | EIA: Public Assembly | [43] |
| Small Office | 110 | 1.1 GPD per person | Assumes 100 people | NREL: Office | [44] |
| Small Retail | 27 | 3.43 GPD per 1,000 SF | Assumes 8,000 SF | EIA: Mercantile | [43] |
| University | 1,000 | 0.5 GPD per student | Assumes 2,000 students | NREL: School | [44] |
| Warehouse | 465 | 0.93 GPD per 1,000 SF | Assumes 500,000 SF | EIA: Warehouse and Storage | [43] |
| Other | Calculate | 4.89 GPD per 1,000 SF |  | EIA: Other | [43] |

Table 3‑357 Thermal efficiency baseline

|  |  |
| --- | --- |
| Electric | Gas |
| 0.98 | 0.80 |

Peak Factors

Table 3‑358 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [52] |
| 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 | [50] |

References

1. 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
2. National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011
3. Water Research Foundation: Residential End Uses of Water, Version 2, April 2016
4. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010
5. 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.
6. 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.
7. 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
8. 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.
9. Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022
10. 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>.

### 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

Where,

For baseline of large electric storage type water heaters (> 12kW and > 20 gallons):

Annual Fuel Savings

Where,

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):

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑359 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔTmain | Average temperature difference between water heater set point and the supply water temperature in water main | Calculated | °F |  |
| ΔTamb | Average temperature difference between water heater set point and the surrounding ambient air temperature | Calculated | °F |  |
| UAb | Overall heat loss coefficient of the baseline condition, calculate based on baseline standby loss | Calculated | N/A |  |
| Et,q | Thermal efficiency for energy efficient measure | Site-specific | N/A |  |
| GPD | Gallons per day | Site-specific, if unknown look up in Table 3‑360 | Gal/day | [53][54] [55][56] |
| *vb* | Baseline tank volume | Site-specific, if unknown use 120 | gal |  |
| *Qb* | Baseline input capacity | Site-specific, if unknown use 200,000 | Btu/h |  |
| Et,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 | [59] |
| Tset | Water heater set point temperature | Site-specific, if unknown use 125 | °F | [57] |
| Tmain | Supply water temperature in water main | 60 | °F | [58] |
| Tamb | Surrounding ambient air temperature | 70[[187]](#footnote-189) | °F |  |
| 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 3‑361 | N/A |  |
| PDF | Peak day factor | Look up in Table 3‑361 | 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 3‑360 GPD by Facility Type[[188]](#footnote-190)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 | [53] |
| Auto Repair | 25 | 4.89 GPD per 1,000 SF | Assumes 5,150 SF, 10% hot water | EIA: Other | [53] |
| Big Box Retail | 448 | 3.43 GPD per 1,000 SF | Assumes 130,500 SF, 10% hot water | EIA: Mercantile | [53] |
| Community College | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL School with Showers | [54] |
| Dormitory | 8,600 | 17.2 GPD per resident | Assumes 500 residents | Water Research Foundation | [55] |
| Elementary School | 250 | 0.5 GPD per student | Assumes 500 students | NREL: School | [54] |
| Fast Food Restaurant | 500 | 500 GPD per restaurant |  | FSTC: Quick Service | [56] |
| Full-Service Restaurant | 2,500 | 2,500 GPD per restaurant |  | FSTC: Full Service | [56] |
| Grocery | 172 | 3.43 GPD per 1,000 SF | Assumes 50,000 SF, 10% hot water | EIA: Mercantile | [53] |
| High School | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL: School with Showers | [54] |
| Hospital | 16,938 | 54.42 GPD per 1,000 SF | Assumes 40% hot water, 250,000 SF | 250,000 SF EIA: Health Care, Inpatient | [53] |
| Hotel | 9,104 | 45.52 GPD per 1,000 SF | Assumes 40% hot water, 200,000 SF | EIA: Lodging | [53] |
| Large Office | 550 | 1.1 GPD per person | Assumes 500 people | NREL: Office | [54] |
| Large Retail | 446 | 3.43 GPD per 1,000 SF | Assumes 130,000 SF, 10% hot water | EIA: Mercantile | [53] |
| Light Industrial | 489 | 4.89 GPD per 1,000 SF | Assumes 100,000 SF, 10% hot water | EIA: Other | [53] |
| Motel | 1,366 | 45.52 GPD per 1,000 SF | Assumes 30,000 SF, 40% hot water | EIA: Lodging | [53] |
| Multifamily High-Rise | 4,550 | 45.5 GPD per unit | Assumes 100 units | Water Research Foundation | [55] |
| Multifamily Low-Rise | 546 | 45.5 GPD per unit | Assumes 12 units | Water Research Foundation | [55] |
| Refrigerated Warehouse | 86 | 0.93 GPD per 1,000 SF | Assumes 92,000 SF, 10% hot water | EIA: Warehouse and Storage | [53] |
| Religious | 77 | 7.02 GPD per 1,000 SF | Assumes 11,000 SF,10% hot water | EIA: Public Assembly | [53] |
| Small Office | 110 | 1.1 GPD per person | Assumes 100 people | NREL: Office | [54] |
| Small Retail | 27 | 3.43 GPD per 1,000 SF | Assumes 8,000 SF, 10% hot water | EIA: Mercantile | [53] |
| University | 1,000 | 0.5 GPD per student | Assumes 2,000 students | NREL: School | [54] |
| Warehouse | 465 | 0.93 GPD per 1,000 SF | Assumes 500,000 SF, , 10% hot water | EIA: Warehouse and Storage | [53] |
| Other | Calculate | 4.89 GPD per 1,000 SF | Assumes 10% hot water | EIA: Other | [53] |

Peak Factors

Table 3‑361 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [60] |
| 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 3‑362 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | New construction EUL | Retrofit RUL | Ref |
| Instantaneous Water Heater | 20 | 6.66 | [61] |

References

1. 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.
2. National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011.
3. *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>
4. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010.
5. 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.
6. Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory, 2022.
7. Fuel: 10 CFR 431.110 (a), December 2022.
8. 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>
9. 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>

### Heat Pump Water Heater

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS/NC/EREP/DI |
| Baseline | Code/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | September 2024 |
| Changes Since Last Version |  |

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). If the HVAC system is unknown, one may calculate savings for each scenario and use the average savings, using the following space heat fuel splits:

|  |  |
| --- | --- |
| •Gas = 93% | •Boiler = 37% of gas heat  •Furnace = 63% of gas heat |
| •Electric heat = 7% | •Air source heat pump = 22% of electric heat  •Other = 78% of electric heat |

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, use dual baselines. The baseline equipment for the first baseline period is the site-specific existing equipment. The baseline equipment for the second baseline period 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

Where,

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑363 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhdhw | Annual domestic hot water electric energy savings | Calculated | kWh/yr |  |
| ΔkWhcooling | Annual cooling electric energy savings | Calculated | kWh/yr |  |
| ΔkWhheating | Annual heating electric energy impacts | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsdhw | Annual domestic hot water fuel savings | Calculated | Therms/yr |  |
| ΔThermsheat | Annual space heating fuel impacts | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Loaddhw | Annual hot water load | Calculated | Btu |  |
| GPD | Gallons per day | Look up in Table 3‑364  If building type or size unknown, use 64 | Gal/day | [67] |
| vr | Rated storage volume | Site-specific | Gal |  |
| Et | Thermal efficiency of space heating boiler or furnace | Site-specific, if unknown, look up in Table 3‑369 | N/A | [64] |
| UEFq | Uniform energy factor of efficient unit | Site-specific, if unknown look up in Table 3‑366 | N/A | [63] |
| UEFb | Uniform energy factor of baseline unit | Look up in Appendix E: Code-Compliant Efficiencies | N/A | [63] |
| Fderate | Efficiency derating factor | Look up in Table 3‑371 | N/A | [64] |
| Flocation | Installation location factor | Look up in Table 3‑371 | N/A |  |
| FDHW,electric | Electric water heating factor | Look up in Table 3‑365 | N/A |  |
| FDHW,ff | Fossil fuel water heating factor | Look up in Table 3‑365 | N/A |  |
| FDHW,boiler | Fossil fuel boiler heating factor | Look up in Table 3‑365 | N/A |  |
| Fheat.electric | Electric heating factor | Look up in Table 3‑365 | N/A |  |
| Fheat,ff | Fossil fuel heating factor | Look up in Table 3‑365 | N/A |  |
| Fheat | 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 | [68] |
| Fcool | 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 | [68] |
| IEER | Space cooling Integrated energy efficiency ratio | Look up in Table 3‑368 | Btu/W·hr | [67] |
| COP | Space heating COP | Look up in Table 3‑366 | N/A | [67] |
| Tmain | Supply water temperature in water main | Look up in Table 3‑370 | °F | [66] |
| FETD | Energy to demand factor | Look up in Table 3‑371 | N/A |  |
| Tset | Water heater setpoint temperature | Site-specific, if unknown use 125 | °F | [62] |
| 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 3‑372 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑372 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Table 3‑364 Gallons Per Day[[189]](#footnote-191)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Building Type | GPD | Rate | Notes/Assumptions | Source | Ref |
| Assembly | 239 | 7.02 GPD per 1,000 SF | Assumes 34,000 SF | EIA926: Public Assembly | [69] |
| Auto Repair | 25 | 48.9 GPD per 1,000 SF | Assumes 5,150 SF | EIA: Other | [69] |
| Big Box Retail | 448 | 34.3 GPD per 1,000 SF | Assumes 130,500 SF | EIA: Mercantile | [69] |
| Community College | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL927: School with Showers | [70] |
| Dormitory | 8,600 | 17.2 GPD per resident | Assumes 500 residents | Water Research Foundation928 | [71] |
| Elementary School | 250 | 0.5 GPD per student | Assumes 500 students | NREL: School | [70] |
| Fast Food Restaurant | 500 | 500 GPD per restaurant |  | FSTC929: Quick Service | [72] |
| Full-Service Restaurant | 2,500 | 2,500 GPD per restaurant |  | FSTC: Full Service | [72] |
| Grocery | 172 | 3.43 GPD per 1,000 SF | Assumes, 50,000 SF | EIA: Mercantile | [69] |
| High School | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL: School with Showers | [70] |
| Hospital | 16,938 | 54.42 GPD per 1,000 SF | Assumes 250,000 SF | EIA: Health Care, Inpatient | [69] |
| Hotel | 9,104 | 45.52 GPD per 1,000 SF | Assumes 200,000 SF | EIA: Lodging | [69] |
| Large Office | 550 | 1.1 GPD per person | Assumes 500 people | NREL: Office | [70] |
| Large Retail | 446 | 3.43 GPD per 1,000 SF | Assumes 130,000 SF | EIA: Mercantile | [69] |
| Light Industrial | 489 | 4.89 GPD per 1,000 SF | Assumes 100,000 SF | EIA: Other | [69] |
| Motel | 1,366 | 45.52 GPD per 1,000 SF | Assumes 30,000 SF | EIA: Lodging | [69] |
| Multifamily High-Rise | 4,600 | 46 GPD per unit | Assumes 100 units | Water Research Foundation | [71] |
| Multifamily Low-Rise | 552 | 46 GPD per unit | Assumes 12 units | Water Research Foundation | [71] |
| Refrigerated Warehouse | 86 | 0.93 GPD per 1,000 SF | Assumes 92,000 SF | EIA: Warehouse and Storage | [69] |
| Religious | 77 | 7.02 GPD per 1,000 SF | Assumes 11,000 SF | EIA: Public Assembly | [69] |
| Small Office | 110 | 1.1 GPD per person | Assumes 100 people | NREL: Office | [70] |
| Small Retail | 27 | 3.43 GPD per 1,000 SF | Assumes 8,000 SF | EIA: Mercantile | [69] |
| University | 1,000 | 0.5 GPD per student | Assumes 2,000 students | NREL: School | [70] |
| Warehouse | 465 | 0.93 GPD per 1,000 SF | Assumes 500,000 SF | EIA: Warehouse and Storage | [69] |
| Other | Calculate | 4.89 GPD per 1,000 SF |  | EIA: Other | [69] |

Table 3‑365 DHW and Heating Savings Factors

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Baseline Scenario | FDHW,electric | FDHW,ff | Fheat,electric | Fheat,ff |
| NC/TOS: Use electric baseline | 1.0 | 0 | 1.0 | 0 |
| EREP/DI with electric dhw and electric heat baseline | 1.0 | 0 | 1.0 | 0 |
| EREP/DI with fuel dhw and fuel heat baseline | 0 | 1.0 | 0 | 1.0 |
| EREP/DI with electric dhw and fuel heat baseline | 1.0 | 0 | 0 | 1.0 |
| EREP/DI with fuel dhw and electric heat baseline | 0 | 1.0 | 1.0 | 0 |

Table 3‑366 Efficient COPq

|  |  |
| --- | --- |
| Product Class | COPq |
| Commercial Heat Pump Water Heater | 3.0 |

Table 3‑367 Derating Factors

|  |  |  |
| --- | --- | --- |
| Area | Fderate | Flocation |
| Unconditioned Space | 0.77 | 0 |
| Conditioned Space | 1.16 | 1 |
| Kitchen | 1.45 | 1 |
| Unknown (Midstream Delivery) | 1.00 | 1 |

Table 3‑368 IEER and COP Values

|  |  |  |
| --- | --- | --- |
| Type | IEER | COP |
| Air Conditioner | 12.7 | 1.0 |
| Air-Source Heat Pump | 12.7 | 3.3 |

Table 3‑369 Et Values

|  |  |  |
| --- | --- | --- |
| Equipment Type | Size Range | Et |
| 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 3‑370 Supply Water Temperature

|  |  |
| --- | --- |
| Climate Region | Tmain |
| Northern | 56 |
| Southwest | 58 |
| Coastal | 60 |
| Central | 58 |
| Pine Barrens | 58 |
| Statewide Average | 58 |

Table 3‑371 FETD 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 3‑372 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.

3‑373 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Heat Pump Water Heater | 10 | 3.37 | [65] |

References

1. 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.
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 Commercial Water Heaters, Eligibility Criteria, Version2.0. (2021),
4. 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
5. NSRDB, TMY3 data, December 2022. <https://nsrdb.nrel.gov/data-sets/tmy>
6. International Energy Conservation Code (IECC) 2022
7. From NY TRM V10, Pg 128
8. 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
9. National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011
10. Water Research Foundation: Residential End Uses of Water, Version 2, April 2016
11. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010

### Faucet Aerators and Showerheads

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | TOS, RF |
| Baseline | Code, Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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) per unit from the baseline (existing) fixture to the efficient low-flow 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

For TOS, the baseline is a standard faucet or a showerhead meeting maximum flow given in the NJ A5160 [73]. For retrofit applications,, the actual flow rate of the existing faucet should be used in the algorithm below.

Efficient Case

The efficient condition is an energy efficient faucet aerator or showerhead with rated flow rate less than maximum flow rate given in the NJ A5160 [6]. Actual flow rates of the installed fixture are used to estimate the savings.

Annual Energy Savings Algorithm

Annual Electric Energy Savings

Where,

Annual Fuel Savings

Peak Demand Savings

Where,

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑374 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔH2O | Annual water savings | Calculated | Gal/yr |  |
| HoursFA | Annual electric DHW recovery hours for faucet aerators | Calculated | hr/yr |  |
| HoursSH | Annual electric DHW recovery hours for showerheads | Calculated | hr/yr |  |
| tmin/day | Average minutes of fixture use per day | Calculated. If unknown, use 30 (faucet) or 20 (showerhead) | min/day | [75] |
| GPMb | Flowrate of baseline fixture | For DI: Site-specific  For RF: Look up in Table 3‑375 | Gal/min | [73] |
| GPMq | Flowrate of efficient fixture | Site-specific | Gal/min |  |
| Nuses/day | Number of times the fixture is used per day | Site-specific. If unknown, use 60 (faucet) or 2.4 (showerhead) | /day | [75] |
| days | Days fixture used per year | Site-specific. If unknown, look up in Table 3‑376 | days/yr | [82] |
| Toperating | Fixture operating temperature | Look up in Table 3‑375 | °F |  |
| Tmain | Temperature of supply water temperature in water main[[190]](#footnote-192) | 60 | °F | [76] |
| Fthrottle,b | Flowrate restricted: ratio of user setting to full throttle flow rate for baseline fixture | 0.83 (faucets)  0.90 (showerheads) | N/A | [74] |
| Fthrottle,q | Flowrate rescrticted: ratio of user setting to full throttle flowrate for efficient fixture | 0.95 (faucets)  0.90 (showerheads) | N/A | [74] |
| tmin/use | Average duration a fixture runs each time it is used | 0.5 (faucet)  8.2 (showerhead) | min | [75] |
| GPH | Gallon per hour recovery of electric water heater | 53.9 | Gal/hr |  |
| Et,elec | Thermal efficiency of electric water heater | 0.98 | N/A | [78] |
| Et,fuel | Thermal efficiency of fossil fuel water heater | 0.80 | N/A | [78] |
| 0.44 | Proportion of hot 140°F water mixed with 50.7°F supply water to give 90°F mixed faucet water | 0.44 | N/A |  |
| 0.608 | Proportion of hot 140°F water mixed with 50.7°F supply water to give 105°F shower water | 0.608 | 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 |  |
| CF | Coincidence factor | Look up in Table 3‑377 | N/A | [81] |
| PDF | Peak day factor | Look up in Table 3‑377 | N/A |  |
| EUL | Effective useful life of new unit | See Measure Life Section | Years |  |

Table 3‑375 Installed Flowrates and Fixture Operating Temperatures

|  |  |  |  |
| --- | --- | --- | --- |
| Fixture Type | Location | GPMb | Toperating(°F) |
| Faucet aerator | Kitchen | 1.8 | 93 |
| Public restroom | 0.5 | 86 |
| Private restroom | 1.5 | 86 |
| Showerhead | Any | 2.0 | 105 |

Table 3‑376 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 |

Peak Factors

Table 3‑377 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) – Faucet Aerators | Lookup in Table 3‑378 | [81] |
| Electric coincidence factor (CF) – Showerheads | 0.0278 | [81] |
| Natural gas peak day factor (PDF) | See Appendix G |  |

Table 3‑378 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:

Measure Life

Table 3‑379 Measure Life

|  |  |  |
| --- | --- | --- |
| Equipment | EUL | Ref |
| Faucet Aerators and Showerheads | 10 | [79] |

References

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10. 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

### Combination Boiler

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Type | TOS/NC/EREP/DI |
| Baseline Condition | Code/Existing/Dual |
| End Use Subcategory | Equipment |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

Where*,*

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

No dual baseline:

Dual baseline:

Lifetime Fuel Energy Savings

No dual baseline:

Dual baseline:

Calculation Parameters

Table 3‑380 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| ΔThermsBoiler | Annual fuel savings from space heating | Calculated | Therms/day |  |
| ΔThermsDHW | Annual fuel savings from water heating | Calculated | Therms/day |  |
| Capin | Input capacity of qualifying boiler | Site-specific | kBtu/hr |  |
| Effq | Boiler proposed efficiency | Site-specific | N/A |  |
| EFLHh | Boiler equivalent full load hours of operation during heating season | Look up in Appendix C: | Hours | [83] |
| Effb | Boiler baseline efficiency | Look up in Appendix E: Code-Compliant Efficiencies | N/A | [89][90][91] |
| GPD | Gallons per day of hot water use | Look up in Table 3‑381  If building type or size unknown, use 64 GPD[[191]](#footnote-193) | Gal/day | [92][93][94][95] |
| 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/gal̇⋅F |  |
| 100,000 | Unit conversion, Btu/therm | 100,000 | Btu/therm |  |
| Et,b | Baseline water heating designation thermal efficiency | 0.8 | N/A | [86] |
| Tset | Water heater setpoint temperature | Site-specific, if unknown use 125 | °F | [84] |
| Tmain | Incoming water main temperature[[192]](#footnote-194) | 60 | °F | [85] |
| UAb | Overall heat loss coefficient of the baseline condition[[193]](#footnote-195) | 7.85 | Btu/h⋅F | [87] |
| Tamb | Surrounding ambient air temperature[[194]](#footnote-196) | 70 | °F |  |
| 8,760 | Hours in one year | 8760 | Hours |  |
| PDF | Peak day factor | Look up in Table 3‑382 | N/A |  |
| EUL | Estimated useful life | See Measure Life Section | Years | [88] |

Table 3‑381 Gallons Per Day (GPD)[[195]](#footnote-197)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 | [93] |
| Auto Repair | 25 | 4.89 GPD per 1,000 SF | Assumes 5,150 SF, 10% hot water | EIA: Other | [93] |
| Big Box Retail | 448 | 3.43 GPD per 1,000 SF | Assumes 130,500 SF, 10% hot water | EIA: Mercantile | [93] |
| Community College | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL School with Showers | [94] |
| Dormitory | 8,600 | 17.2 GPD per resident | Assumes 500 residents | Water Research Foundation | [95] |
| Elementary School | 250 | 0.5 GPD per student | Assumes 500 students | NREL: School | [94] |
| Fast Food Restaurant | 500 | 500 GPD per restaurant |  | FSTC: Quick Service | [96] |
| Full-Service Restaurant | 2,500 | 2,500 GPD per restaurant |  | FSTC: Full Service | [96] |
| Grocery | 172 | 3.43 GPD per 1,000 SF | Assumes 50,000 SF, 10% hot water | EIA: Mercantile | [93] |
| High School | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL: School with Showers | [94] |
| Hospital | 16,938 | 54.42 GPD per 1,000 SF | Assumes 40% hot water, 250,000 SF | 250,000 SF EIA: Health Care, Inpatient | [93] |
| Hotel | 9,104 | 45.52 GPD per 1,000 SF | Assumes 40% hot water, 200,000 SF | EIA: Lodging | [93] |
| Large Office | 550 | 1.1 GPD per person | Assumes 500 people | NREL: Office | [94] |
| Large Retail | 446 | 3.43 GPD per 1,000 SF | Assumes 130,000 SF, 10% hot water | EIA: Mercantile | [93] |
| Light Industrial | 489 | 4.89 GPD per 1,000 SF | Assumes 100,000 SF, 10% hot water | EIA: Other | [93] |
| Motel | 1,366 | 45.52 GPD per 1,000 SF | Assumes 30,000 SF, 40% hot water | EIA: Lodging | [93] |
| Multifamily High-Rise | 4,550 | 45.5 GPD per unit | Assumes 100 units | Water Research Foundation | [95] |
| Multifamily Low-Rise | 546 | 45.5 GPD per unit | Assumes 12 units | Water Research Foundation | [95] |
| Refrigerated Warehouse | 86 | 0.93 GPD per 1,000 SF | Assumes 92,000 SF, 10% hot water | EIA: Warehouse and Storage | [93] |
| Religious | 77 | 7.02 GPD per 1,000 SF | Assumes 11,000 SF,10% hot water | EIA: Public Assembly | [93] |
| Small Office | 110 | 1.1 GPD per person | Assumes 100 people | NREL: Office | [94] |
| Small Retail | 27 | 3.43 GPD per 1,000 SF | Assumes 8,000 SF, 10% hot water | EIA: Mercantile | [93] |
| University | 1,000 | 0.5 GPD per student | Assumes 2,000 students | NREL: School | [94] |
| Warehouse | 465 | 0.93 GPD per 1,000 SF | Assumes 500,000 SF, , 10% hot water | EIA: Warehouse and Storage | [93] |
| Other | Calculate | 4.89 GPD per 1,000 SF | Assumes 10% hot water | EIA: Other | [93] |

Peak Factors

Table 3‑382 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 3‑383 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| Combination Boiler | 22 | 7.3 | [88] |

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9. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010 E

### Pre-Rinse Spray Valves (PRSV)

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF/ TOS |
| Baseline | Existing |
| End Use Subcategory | Water Conservation |
| Measure Last Reviewed | December 2022 |
| Changes Since Last Version |  |

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 spray 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.

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

Where,

Annual Fuel Savings

Where,

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

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 |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔT | Average temperature different between PRSV operating temperature and the supply water temperature | 60 | °F | [99][101] |
| Nunits | Number of fixtures | Site-specific | N/A |  |
| GPMq | Flow rate of the installed prsv | Site-specific. If unknown, use 1.28 | Gal/min | [106] |
| Days/year | Number of days the fixture is in use in one year | Site-specific. If unknown, look up in Table 3‑386 | Days/year | [109] |
| Et, elc | Thermal Efficiency for electrical heaters | Site-specific. If unknown, assume 98% | N/A | [107] |
| Et, fuel | Thermal efficiency for fuel heaters | Site-specific. If unknown, assume 80% | N/A | [108] |
| ETDF | Energy to Demand Factor | Look up in Table 3‑387 | (kW/ kWh/yr) | [105] |
| GPMb | Flow rate of the baseline prsv | Site-specific. If unknown, use 1.6 | Gal/min | [97] [98] |
| Hours/day | Operating hours of fixture usage per day | Look up in Table 3‑385 Operating Hours/Day | Hours/day |  |
| FElec | Factor to account for electric water heat[[196]](#footnote-198) | If building water heat fuel is electric: 1  If building water heat fuel is not electric: 0  If unknown: 0.28 |  |  |
| FFuel | Factor to account for fuel water heat | If building water heat fuel is electric: 0  If building water heat fuel is not electric: 1  If unknown: 0.72 |  |  |
| 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 3‑388 | N/A |  |
| PDF | Gas peak day factor | Lookup in Table 3‑388 | 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 3‑385 Operating Hours/Day

|  |  |  |
| --- | --- | --- |
| Facility Type | Hours of Pre-Rinse Spray Value Use Per Day (hours) | Ref |
| Full Service Restaurant | 4 | [101] |
| Limited Service (fast food) Restaurant | 1 | [101] |
| Other | 1.067 | [102] |

Table 3‑386 Operating Days per Year

|  |  |
| --- | --- |
| Building Type | Operating Days per Year |
| Assembly | 355 |
| 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 3‑387 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 3‑388 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 3‑389 Measure Life

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment | EUL | RUL | Ref |
| PRSV | 5 | 1.67 | [105] |

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12. ASHRAE Standards 90.1-2019, *Energy Standard for Buildings Except Low Rise Residential Buildings*. <https://www.ashrae.org/standards-research--technology/standards--guidelines>
13. 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

### Recirculating Pump Control

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Control |
| Measure Last Reviewed | February 2024 |
| Changes Since Last Version |  |

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) [126]. 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

Where,

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms:

Lifetime Electric Energy Savings

Lifetime Fuel Energy Savings

Calculation Parameters

Table 3‑390 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWhPump | Annual electric energy savings from pump | Calculated | kWh/yr |  |
| ΔkWhHW | Annual electric energy savings from hot water | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| HrsRecirc, B | Annual hours of operation of recirculation system in baseline condition | Site-specific, if unknown use 8760 | Hrs/yr |  |
| HP | Pump nameplate horsepower | Site-specific | HP |  |
| EffPump | Pump efficiency | Site-specific, if unknown look up in Table 3‑391 | N/A |  |
| LF | Load factor | Site-specific, if unknown use 0.9 | N/A | [112] |
| GPD | Average daily hot water usage | Site-specific, if unknown look up in Table 3‑392 | Gal/day |  |
| TSet | Water heater set point temperature | Site-specific, if unknown use 125 | °F | [117] |
| ET, Fuel | Thermal efficiency of fossil fuel water heater | Site-specific, if unknown use 0.8 | N/A | [121] |
| ESFHW | Hot water energy savings factor | Look up in Table 3‑394 | N/A | [125] |
| FDHW, Elec | Electric water heating factor | Look up in Table 3‑393 | N/A |  |
| FDHW, Fuel | Fossil fuel water heating factor | Look up in Table 3‑393 | N/A |  |
| CF | Electric coincidence factor | Look up in Table 3‑395 | N/A |  |
| PDF | Gas peak demand factor | Look up in Table 3‑395 | N/A |  |
| TMain | Supply water temperature in water main[[197]](#footnote-199) | 60 | °F | [118] |
| ET,Elec | Thermal efficiency of electric water heater | 0.98 | N/A | [124] |
| ESFPump | Pump energy savings factor | 0.87 | N/A | [123] |
| 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 |  |

Table 3‑391 Pump Efficiency

|  |  |  |
| --- | --- | --- |
| Pump Type | Value | Reference |
| PSC | 0.60 | [110] |
| ECM | 0.80 | [111] |
| Unknown | 0.80 |  |

Table 3‑392 Average Daily Hot Water Usage[[198]](#footnote-200)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 | [113] |
| Auto Repair | 25 | 4.89 GPD per 1,000 SF | Assumes 5,150 SF, 10% hot water | EIA: Other | [113] |
| Big Box Retail | 448 | 3.43 GPD per 1,000 SF | Assumes 130,500 SF, 10% hot water | EIA: Mercantile | [113] |
| Community College | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL School with Showers | [114] |
| Dormitory | 8,600 | 17.2 GPD per resident | Assumes 500 residents | Water Research Foundation | [115] |
| Elementary School | 250 | 0.5 GPD per student | Assumes 500 students | NREL: School | [114] |
| Fast Food Restaurant | 500 | 500 GPD per restaurant |  | FSTC: Quick Service | [116] |
| Full-Service Restaurant | 2,500 | 2,500 GPD per restaurant |  | FSTC: Full Service | [116] |
| Grocery | 172 | 3.43 GPD per 1,000 SF | Assumes 50,000 SF, 10% hot water | EIA: Mercantile | [113] |
| High School | 1,520 | 1.9 GPD per person | Assumes 800 students | NREL: School with Showers | [114] |
| Hospital | 16,938 | 54.42 GPD per 1,000 SF |  | 250,000 SF EIA: Health Care, Inpatient | [113] |
| Hotel | 9,104 | 45.52 GPD per 1,000 SF | Assumes 40% hot water, 200,000 SF | EIA: Lodging | [113] |
| Large Office | 550 | 1.1 GPD per person | Assumes 500 people | NREL: Office | [114] |
| Large Retail | 446 | 3.43 GPD per 1,000 SF | Assumes 130,000 SF, 10% hot water | EIA: Mercantile | [113] |
| Light Industrial | 489 | 4.89 GPD per 1,000 SF | Assumes 100,000 SF, 10% hot water | EIA: Other | [113] |
| Motel | 1,366 | 45.52 GPD per 1,000 SF | Assumes 30,000 SF, 40% hot water | EIA: Lodging | [113] |
| Multifamily High-Rise | 4,600 | 46 GPD per unit | Assumes 100 units | Water Research Foundation | [115] |
| Multifamily Low-Rise | 552 | 46 GPD per unit | Assumes 12 units | Water Research Foundation | [115] |
| Refrigerated Warehouse | 86 | 0.93 GPD per 1,000 SF | Assumes 92,000 SF, 10% hot water | EIA: Warehouse and Storage | [113] |
| Religious | 77 | 7.02 GPD per 1,000 SF | Assumes 11,000 SF, 10% hot water | EIA: Public Assembly | [113] |
| Small Office | 110 | 1.1 GPD per person | Assumes 100 people | NREL: Office | [114] |
| Small Retail | 27 | 3.43 GPD per 1,000 SF | Assumes 8,000 SF, 10% hot water | EIA: Mercantile | [113] |
| University | 1,000 | 0.5 GPD per student | Assumes 2,000 students | NREL: School | [114] |
| Warehouse | 465 | 0.93 GPD per 1,000 SF | Assumes 500,000 SF, 10% hot water | EIA: Warehouse and Storage | [113] |
| Other | Calculate | 4.89 GPD per 1,000 SF |  | EIA: Other | [113] |

Table 3‑393 Water Heating Factors

|  |  |  |
| --- | --- | --- |
| DHW System | FDHW,Elec | FDHW,Fuel |
| Electric | 1.0 | 0.0 |
| Fossil Fuel | 0.0 | 1.0 |

Table 3‑394 Hot Water Energy Savings Factors

|  |  |
| --- | --- |
| Control Type | ESFHW |
| Demand Control | 0.07 |
| Temperature Modulation | 0.02 |
| Demand Control and Temperature Modulation | 0.15 |

Peak Factors

Table 3‑395 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | 0.8 | [122] |
| Natural gas peak day factor (PDF) | See Appendix G: Natural Gas Peak Day Factors |  |

Measure Life

The effective useful life (EUL) is 15 years [120].

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### Pipe Insulation

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | RF |
| Baseline | Existing |
| End Use Subcategory | Insulation |
| Measure Last Reviewed | November 2022 |
| Changes Since Last Version |  |

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

Annual Fuel Savings

*Peak Demand Savings*

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑396 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhlife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermslife | Lifetime fuel savings | Calculated | Therms |  |
| L | Length of installed insulation | Site-specific | ft |  |
| Tpipe | Average temperature of hot water or steam in distribution system piping | Site-specific, if unknown lookup in  Table 3‑401 | °F | [130][131][134] |
| Tamb | Surrounding average ambient air temperature | Site-specific, if unknown: DHW: 70  Space Heat: 50 | °F | [138] |
| Etfuel | Recovery Efficiency of fuel water heaters or AFUE of boiler for space heating | Site-specific, if unknown:  DHW[[199]](#footnote-201): 0.8  Space Heating Boilers: Lookup in Table 3‑399 | N/A | [135][136] |
| Etelec | Recovery Efficiency of electric water heaters | Site-specific, if unknown:  Non-Heat Pump DHW[[200]](#footnote-202): 0.98  Heat Pump DHW: Lookup in Table 3‑400 | N/A | [308][129] |
| hrs | Equivalent full load heating hours | Site-specific, if unknown:  DHW: 8,760  Boilers: Lookup heating EFLH in Appendix C: Heating and Cooling EFLH | hrs | [234][234] |
| (UA/L)b | Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from uninsulated pipe[[201]](#footnote-203) | Lookup in  Table 3‑397 | Btu/hr-°F-ft | [132] |
| (UA/L)q | Product of Overall Heat Transfer Coefficient and Pipe Area (UA) per foot from insulated pipe202 | Lookup in  Table 2‑208 | Btu/hr-°F-ft | [140] |
| SFelec | Adjustment to electric water heating energy savings when water heating fuel is unknown | Electric WH: 1.0  Unknown WH: 0.55 | N/A | [133] |
| SFfuel | Adjustment to fossil fuel water heating energy savings based on water heating fuelf | Fossil Fuel WH & Space Heating: 1.0  Unknown WH: 0.56 | N/A | [133] |
| CF | Electric coincidence factor | Lookup in Table 3‑152 | N/A |  |
| PDF | Gas peak day factor | Lookup in Table 3‑152 | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Table 3‑397 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 |
| 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 3‑398 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 3‑399 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| [Equipment](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#equipment) Type | Subcategory or Rating Condition | Size Category (Input) | [Efficiency](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#efficiency) as of 3/2/2022 | Test Procedure |
| [Boilers](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#boiler), hot water | Gas fired | <300,000 Btu/h | 82% [AFUE](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#annual_fuel_utilization_efficiency_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 |
| Oil fired | <300,000 Btu/h | 84% [AFUE](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#annual_fuel_utilization_efficiency_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](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#boiler), steam | Gas fired | <300,000 Btu/h | 80% [AFUE](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#annual_fuel_utilization_efficiency_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](https://up.codes/viewer/new_jersey/ashrae-90.1-2019/chapter/3/definitions-abbreviations-and-acronyms#annual_fuel_utilization_efficiency_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 3‑400 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[[202]](#footnote-204) | - | 3.016 |

Table 3‑401 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[[203]](#footnote-205) | C&I | 240 |
| Medium Pressure Steam | Commercial | 304 |
| Medium Pressure Steam | Industrial | 258 |

Peak Factors

Table 3‑402 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 [141].

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## Process

### 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 aircompressor 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑403 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| HP | Compressor motor nominal HP | Site-specific | hp |  |
| COMPb | Baseline compressor factor | Look up in Table 3‑405 | N/A | [144] |
| COMPq | Installed compressor factor, actual | Site-specific, if unknown use 0.705 | N/A | [142] |
| Hrs | Compressor total hours of operation | Site-specific, if unknown look up in Table 3‑404 | Hrs/yr | [142] |
| CF | Coincidence factor | Look up in Table 3‑404 | N/A | [142] |
| PDF | Gas peak demand factor | Look up in Table 3‑406 | N/A |  |
| 0.9 | Compressor motor nominal hp to full load kW Conversion factor | 0.9 | N/A | [142] |
| EUL | Effective useful life of new unit | See Measure Life Section | Years |  |

Table 3‑404 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 3‑405 Baseline Compressor Factor

|  |  |  |
| --- | --- | --- |
| Baseline Compressor | Compressor Factor COMPb  (≤45 hp) | Compressor Factor COMPb  (>45 hp) |
| Modulating w/ Blowdown | 0.890 | 0.863 |
| Load/No Load w/ 1 Gallon-of-storage/ CFMMax | 0.909 | 0.887 |
| Load/No Load w/ 3 Gallon-of-storage/ CFMMax | 0.831 | 0.811 |
| Load/No Load w/ 5 Gallon-of-storage/ CFMMax | 0.806 | 0.786 |

Peak Factors

Table 3‑406 Peak Factors

|  |  |  |
| --- | --- | --- |
| Peak Factor | Value | Ref |
| Electric coincidence factor (CF) | Look up in Table 3‑404 | [142] |
| Natural gas peak day factor (PDF) | N/A |  |

Measure Life

The effective useful life (EUL) is 13 years [143].

References

1. Mid Atlanic 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).
2. 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. 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.

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑407 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| Nleaks | Number of leaks repaired | Site-specific | N/A |  |
| Hrs | Hours of operation per year | Site-specific, if unknown use 6,240 | Hrs/yr | [149] |
| CFMleak | CFM loss per leak | Site-specific, look up in Table 3‑408 | CFM | [145] |
| Effcomp | Compresser efficiency | Site-specific, if unknown look up in Table 3‑409 | kW/CFM | [146] |
| Fcontrol | Control factor, percent kW divided by percent load | Look up in Table 3‑410 | N/A | [147] |
| CF | Electric coincidence factor | Look up in Table 3‑152 | N/A | [148] |
| PDF | Gas peak day factor | Look up in Table 3‑152 | N/A |  |
| EUL | Effective useful life | See Measure Life section | Years |  |

Table 3‑408 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 |
| 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 3‑409 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 3‑410 Efficiency Factors per Control Type

|  |  |
| --- | --- |
| Control Type | Fcontrol (% 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 3‑411 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. [150]

References

1. NREL, Chapter 22: Compressed Air Evaluation Protocol. https://www.energystar.gov/sites/default/files/buildings/tools/compressed\_air3.pdf
2. Data from Compressed Air Challenge "Fundamentals of Compressed Air Systems" Pgs. 28-32
3. NREL, Chapter 22: Compressed Air Evaluation Protocol, October 2017. Pg 16
4. KEMA, New Jersey’s Clean Energy Program Energy Impact Evaluation and Protocol Review, July 10, 2009.
5. 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.
6. One year measure life is based on typical recommendation of annual leak survey.

## Whole Building

### Combined Heat and Power

|  |  |
| --- | --- |
| Market | Commercial |
| Baseline Condition | NC/RF |
| Baseline | Code/Existing |
| End Use Subcategory | HVAC |
| Measure Last Reviewed | August 2024 |
| Changes Since Last Version |  |

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 717[151].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

Where,

Annual Fuel Savings

Where,

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

Lifetime Fuel Savings

Calculation Parameters

Table 3‑412 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Annual peak demand savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| FuelOffset | Reduction in fuel consumption that would have been used for heating that can be attributed to the CHP system | Calculated | kBtu |  |
| FuelConsumed | Utility delivered fuel consumed by CHP system | Calculated | kBtu |  |
| EffNetElec | Net electrical efficiency, a measure of how much of the energy in the fuel input is converted to net electricity | Calculated | N/A |  |
| UHRRC | Useful heat recovery rate for absorption chiller | Calculated | kBtu/kWh |  |
| UHRRh | Useful heat recovery rate associated with heating offset | Calculated | kBtu/kWh |  |
| KWhChillerOffset | Annual electrical energy offset from electrical chillers if heat from the CHP measure is driving an absorption chiller | Calculated | kWh/yr |  |
| kWhgross | Overall electricity generated by CHP System | Site-specific/engineering calculation | kWh/yr |  |
| kWhconsumed | 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 kWhgross | kWh/yr |  |
| UHRh | 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 |  |
| UHRc | Useful heat recovered: heat that is used to drive an absorption chiller | Site-specific/engineering calculation | kBtu |  |
| kWhNet | Net electricity generation by CHP: overall electricity generated by CHP System minus annual electricity consumed by CHP system | Site-specific/engineering calculation | kWh/year |  |
| FuelInput | Annual Fuel input to CHP system | Site-specific/engineering cacluation | kBtu |  |
| COP | COP of absorption chiller | Site-specific | N/A |  |
| EffElecChiller | Efficiency of baseline electric chiller | Site-specific, use 0.65 if unknown | kW/ton | [153] |
| 12 | Conversion factor | 12 | kBtu/ton |  |
| EffBoiler | Efficiency of boiler that would serve heating loads in absence of CHP system | Site-specific, use 0.8 if unknown | N/A | [126] |
| 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 reductions in addition to energy savings. Annual and lifetime air emission reductions resulting from electric generation, electric savings, and net gas impacts at the system level shall be calculated as specified below:

Annual Emissions Reductions

Lifetime Emissions Reductions

Table 3‑413 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔCO2MT | Annual CO2 Emissions Reductions, in Metric Tons | Calculated | MT/yr |  |
| ΔSO2MT | Annual SO2 Emissions Reductions, in Metric Tons | Calculated | MT/yr |  |
| ΔNOxMT | Annual NOx Emissions Reductions, in Metric Tons | Calculated | MT/yr |  |
| ΔHgg | Annual Hg Emissions Reductions, in grams | Calculated | g/yr |  |
| ΔCO2MT,Life | Lifetime CO2 Emissions Reductions, in Metric Tons | Calculated | MT |  |
| ΔSO2MT,Life | Lifetime SO2 Emissions Reductions, in Metric Tons | Calculated | MT |  |
| ΔNOxMT,Life | Lifetime NOx Emissions Reductions, in Metric Tons | Calculated | MT |  |
| ΔHgg,Life | Lifetime Hg Emissions Reductions, in grams | Calculated | g |  |
| ΔMWhsav | Annual electric energy savings | Site-specific/engineering calculation | MWh/yr |  |
| ΔTherms | Annual fuel savings | Site-specific/engineering calculation | Therms/yr |  |
| ΔMWhgen | Annual electric generation | Site-specific/engineering calculation | MWh/yr |  |
| ΔMWhsav,Life | Lifetime electric energy savings | Site-specific/engineering calculation | MWh |  |
| ΔThermsLife | Lifetime fuel savings | Site-specific/engineering calculation | Therms |  |
| ΔMWhgen,Life | Lifetime electric generation | Site-specific/engineering calculation | MWh |  |
| LLFelec | Electric line loss factor | 1.087 | N/A | [156] |
| LLFgas | Gas line loss factor | 1.023 | N/A | [156] |
| FCO2,elec | Grid electric CO2 emissions factor | Lookup from NJBPU Order [156], Attachment B, Table 6 based on year of installation | tons/MWh | [156] |
| FSO2,elec | Grid electric SO2 emissions factor | Lookup from NJBPU Order [156], Attachment B, Table 6 based on year of installation | tons/MWh | [156] |
| FNOx,elec | Grid electric NOx emissions factor | Lookup from NJBPU Order [156], Attachment B, Table 6 based on year of installation | tons/MWh | [156] |
| FHg,elec | Grid electric Hg emissions factor | 1.1 | mg/MWh | [157] |
| FCO2,gas | Natural gas CO2 emissions factor | 0.058325 | tons/MMBtu | [158] |
| FNOx,gas | Grid electric NOx emissions factor | 0.000046 | tons/MMBtu | [157] |
| FCO2,CHP | CHP system electric generation CO2 emissions factor | Site-specific | tons/MWh |  |
| FSO2,CHP | CHP system electric generation SO2 emissions factor | Site-specific | tons/MWh |  |
| FNOx,CHP | CHP system electric generation NOx emissions factor | Site-specific | tons/MWh |  |
| AVG(FCO2,elec) | Average lifetime grid electric CO2 emissions factor | Average of annual emissions factors over the lifetime of the CHP system from NJBPU Order [156], Attachment B, Table 6 based on year of installation and EUL | tons/MWh | [156] |
| AVG(FSO2,elec) | Average lifetime grid electric SO2 emissions factor | Average of annual emissions factors over the lifetime of the CHP system from NJBPU Order [156], Attachment B, Table 6 based on year of installation and EUL | tons/MWh | [156] |
| AVG(FNOx,elec) | Average lifetime grid electric NOx emissions factor | Average of annual emissions factors over the lifetime of the CHP system from NJBPU Order [156], Attachment B, Table 6 based on year of installation and EUL | tons/MWh | [156] |
| 10 | Conversion factor | 10 | Therms/MMBtu |  |
| 2,000 | Conversion factor | 2,000 | lbs/ton |  |
| 2,205 | Conversion factor | 2,205 | lbs/MT |  |
| 1,000 | Conversion factor | 1,000 | mg/g |  |

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 [151].[[204]](#footnote-206)

References

1. 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>
2. 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>
3. 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>
4. 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>
5. 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>
6. [NJBPU ORDER DIRECTING THE UTILITIES TO PROPOSE SECOND TRIENNIUM ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS](https://www.nj.gov/bpu/pdf/boardorders/2023/20230726/8C%20ORDER%20Second%20Triennium.pdf)
7. [New Jersey’s Clean Energy Program Protocols to Measure Resource Savings FY2020](https://www.njcleanenergy.com/files/file/NJCEP%20Protocols%20to%20Measure%20Resource%20Savings%20FY20_FINAL.pdf)
8. [EIA Fuel Emissions](https://www.eia.gov/environment/emissions/co2_vol_mass.php)

### New Construction

|  |  |
| --- | --- |
| Market | Commercial/Multifamily |
| Baseline Condition | NC |
| Baseline | Code |
| End Use Category | Whole Building |
| Measure Last Reviewed | January 2023 |
| Changes Since Last Version |  |

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) [159], Passive House Institute US [160][339] or Passive House [161].

Minimum energy performance requirements for all new construction projects are measured from baselines reflecting effective, applicable energy codes and standards (e.g., IECC and ASHRAE 90.1) at the time the project permit is 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.

For projects pursuing passive house certifications, savings shall be estimated based on a comparison of baseline and proposed/as-built OR minimally passive house compliant prototype models developed in approved program simulation software. Baseline models shall reflect input parameters relevant to climate zones 4A/5A and minimally compliant with effective, applicable energy codes and standards based on project permit date. Submitted proposed/as-built design models are compared against the corresponding baseline model to establish energy consumption savings by fuel type. For electric peak demand savings, where end use-level kWh savings are reported by simulation software, peak kW shall be established per end use and aggregated for project-level reporting. In the absence of end use-level savings, peak kW savings may be approximated per the equation shown below:

Where:

CF = cooling coincidence factor from Section 3.5.1

EFLHcool= cooling equivalent full load hours from Section 3.5.1

High performance new construction projects in NJ may target varying levels of energy performance, from a bundled measure approach per ASHRAE 90.1 Addendum AP [162] to simple DOE-2 based modeling (e.g., Slipstream’s Sketchbox) to comprehensive modeling per ASHRAE 90.1 Appendix G [163]. Simulation software used for new construction projects must comply with ASHRAE Standard 140 [165].

References

1. [LEED requirements](https://www.usgbc.org/leed)

1. [Passive House Institute US requirements](https://www.phius.org/).
2. [Passive House Institute requirements](https://passivehouse.com/)
3. [ASHRAE Addendum AP](https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_ap_20220909.pdf)
4. [ASHRAE 90.1-2016/2019 Appendix G](https://www.energycodes.gov/performance_based_compliance)
5. [Commercial New Construction Industry Standard Practice Analysis](https://njcleanenergy.com/files/file/Library/FY23/Rutgers%20New%20Jersey%20Commercial%20New%20Construction%20Industry%20Standard%20Practice%20Final%20report_clean.pdf)
6. [ASHRAE Standard 140-2020 Method Of Test For Evaluating Building Performance Simulation Software](https://webstore.ansi.org/standards/ashrae/ansiashrae1402020#PDF)

### 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

Annual Fuel Savings

Peak Demand Savings

Daily Peak Fuel Savings

Lifetime Energy Savings Algorithms

Lifetime Electric Energy Savings

Lifetime Fuel Savings

Calculation Parameters

Table 3‑414 Calculation Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Description | Value | Units | Ref |
| ΔkWh | Annual electric energy savings | Calculated | kWh/yr |  |
| ΔTherms | Annual fuel savings | Calculated | Therms/yr |  |
| ΔkWPeak | Peak Demand Savings | Calculated | kW |  |
| ΔThermsPeak | Daily peak fuel savings | Calculated | Therms/day |  |
| ΔkWhLife | Lifetime electric energy savings | Calculated | kWh |  |
| ΔThermsLife | Lifetime fuel savings | Calculated | Therms |  |
| Ce | Unit area kWh savings constant per participant | 0.482 | kWh/ft2/participant | [166] |
| Area | Building area operated by the participant | Site-specific | ft2 |  |
| Cg | Unit gas savings constant per participant | 0.0145 | Therms/ft2/participant | [167] |
| Cd | Unit demand savings constant per participant | 0.039 | W/ft2/participant | [167] |
| 1,000 | Conversion factor | 1,000 | W/kW |  |
| CF | Electric coincidence factor | Look up in Table 3‑415 | N/A |  |
| PDF | Gas peak day factor | Look up in Table 3‑415 | N/A |  |
| EUL | Effective useful life | See Measure Life Section | Years |  |

Peak Factors

Table 3‑415 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 [168].

References

1. Building Operator Certification, BOC Energy Savings Summary and FAQ available at [2020-BOC-Energy-Savings-FAQ\_1.0.pdf (theboc.info)](https://www.theboc.info/wp-content/uploads/2020/08/2020-BOC-Energy-Savings-FAQ_1.0.pdf)
2. 2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0, Page 805
3. 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.

### 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:[[205]](#footnote-207)

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, 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

1. 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
2. International Measurement and Verification Protocol (IPMVP) available at  [https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp](https://cadmusgroup.com/wp-content/uploads/2016/02/NEEP-CRL_Report_FINAL_clean.pdf?submissionGuid=cb214243-bab8-479a-a4c4-c8e5c64ae7b2)
3. ASHRAE Guideline 14-2014. Available at <https://webstore.ansi.org/standards/ashrae/ashraeguideline142014>

# 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.[[206]](#footnote-208)



A representative city from the TMY3 long term average weather data set was assigned to each of the climate zones.[[207]](#footnote-209) 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.[[208]](#footnote-210)

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.

# 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.[[209]](#footnote-211) The simulations were driven using Typical Meteorological Year (TMY3) long-term average weather data.[[210]](#footnote-212)

## Assembly

A prototypical building energy simulation model for an assembly building 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 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.

A picture containing text, businesscard

Description automatically generated

## Auto Repair

A prototypical building energy simulation model for an auto repair building 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 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 = ,74 U-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.

Shape

Description automatically generated

## Big Box Retail

A prototypical building energy simulation model for a big box retail building 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 prototype are summarized below.

**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 oF cooling, 72 oF heating  Unoccupied hours: 79 oF cooling, 69 oF heating |

A computer-generated sketch of the Big Box Building prototype is shown below.

A picture containing shape

Description automatically generated

## 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 degrees apart. 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.

A picture containing satellite, transport

Description automatically generated

## Dormitory

A prototypical building energy simulation model for a university dormitory was developed using the 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 oF cooling, 72 oF heating  Night setback hours: 81 oF cooling, 67 oF heating |

A computer-generated sketch of the Dormitory Building prototype is shown below.

A picture containing screenshot, line

Description automatically generated

Note: The middle floors, since they thermally equivalent, are simulated as a single floor, and the results are multiplied by 2 to represent the energy consumption of the 2 middle floors.

## Elementary School

A prototypical building energy simulation model for an elementary 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 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.

Engineering drawing

Description automatically generated with medium confidence

## Fast Food Restaurant

A prototypical building energy simulation model for a fast food restaurant 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 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 oF cooling, 72 oF heating  Unoccupied hours: 80 oF cooling, 69 oF heating |

A computer-generated sketch of the Fast Food Building prototype is shown below.

Graphical user interface, diagram, engineering drawing

Description automatically generated

## Full-Service Restaurant

A prototypical building energy simulation model for a full-service restaurant 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 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 oF cooling, 72 oF heating  Unoccupied hours: 80 oF cooling, 69 oF heating |

A computer-generated sketch of the Full-Service Restaurant Building prototype is shown below.

Diagram, engineering drawing

Description automatically generated

## Grocery

A prototypical building energy simulation model for a grocery building was developed using the DOE-2.2R[[211]](#footnote-213) 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 |

A computer-generated sketch of the Grocery Building prototype is shown below.

A picture containing satellite, table, businesscard, night sky

Description automatically generated

## 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 water boiler. |
| HVAC system size | 250 SF/ton |
| Thermostat set points | Occupied hours: 76oF cooling, 72 oF heating  Unoccupied hours: 81oF cooling, 67 oF heating |

A computer-generated sketch of the High School Building prototype is shown below.

A picture containing text, satellite

Description automatically generated

## Hospital

A prototypical building energy simulation model for a large hospital building 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 prototype are summarized below.

**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-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 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. This presents 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.

A picture containing icon

Description automatically generated

## Hotel

A prototypical building energy simulation model for a hotel building was developed using the DOE-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 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, 180 oF set point |
| 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 Hotel Building prototype is shown below.

A solar panel on a black background

Description automatically generated with low confidence

## Large Office

A prototypical building energy simulation model for a large office building 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 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 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, 180 oF set point |
| Thermostat set points | Occupied hours: 75 oF cooling, 70 oF heating  Unoccupied hours: 78 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. This presents 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.

A picture containing screenshot, book, design

Description automatically generated

Note: The middle floors, since they thermally equivalent, are simulated as a single floor, and the results are multiplied by 8 to represent the energy consumption of the eight middle floors.

## Large Retail

A prototypical building energy simulation model for a large retail building 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 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. This presents 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.

A picture containing text

Description automatically generated

## Light Industrial

A prototypical building energy simulation model for a light industrial building 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 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.

A picture containing text, businesscard

Description automatically generated

## Motel

A prototypical building energy simulation model for a motel 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 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: 76oF cooling, 72 oF heating  Night setback hours: 81 oF cooling, 67 oF heating |

A computer-generated sketch of the Motel Building prototype is shown below.

A picture containing text, satellite

Description automatically generated

## Religious

A prototypical building energy simulation model for a religious worship building 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 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, 70 oF heating  Unoccupied hours: 82 oF cooling, 64 oF heating |

A computer-generated sketch of the Religious Building prototype is shown below.

Shape

Description automatically generated

## 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 oF cooling, 72 oF heating  Unoccupied hours: 79 oF cooling, 69 oF heating |

A computer-generated sketch of the Small Office Building prototype is shown below.

A picture containing diagram

Description automatically generated

## Small Retail

A prototypical building energy simulation model for a small retail building 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 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 oF cooling, 72 oF heating  Unoccupied hours: 79 oF cooling, 69 oF heating |

A computer-generated sketch of the Small Retail Building prototype is shown below.

A picture containing text, businesscard, table, coffee table

Description automatically generated

## University

A prototypical building energy simulation model for a university building 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 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. This presents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the University Building prototype is shown below.

Diagram

Description automatically generated

## Warehouse

A prototypical building energy simulation model for a warehouse building was developed using the 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 = 0.84 U-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 oF cooling, 68 oF heating  Unoccupied hours: 85 oF cooling, 63 oF heating |

A computer-generated sketch of the Warehouse Building prototype is shown below.

A picture containing businesscard

Description automatically generated

# Appendix C: Heating and Cooling EFLH

### 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) | 854 | 965  929 (ETG)  841 (SJG) | 854 | 965  929 (ETG)  841 (SJG) | 854 | 965  929 (ETG)  841 (SJG) |
| 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 | 761 | 965 | 761 | 965 | 761 | 965 |

### 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 |
| 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 |
| 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.

### 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.
* If the facility type and size is unknown, weight small commercial values by 0.8 and large commercial values by 0.2 (based on CBECS data). Resulting default EFLH are 842 for cooling and 791 for heating.

Table 6‑4 Small Commercial (less than 3 stories) Cooling Equivalent Full Load Hours (EFLHc)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 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 (EFLHh)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 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 |
| 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) Heating Equivalent Full Load Hours (EFLHh)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| 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 |

# 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 |
| 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 |
| 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** |
| 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** |
| 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** |
| 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** |
| 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** |
| 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** |

# 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 energy code is defined by ASHRAE 90.1-2019 and IECC 2021.
* When a measure calls for exising baseline (EREP/RF/ERET), use the actual site-specific efficiency if possible. If the site-specific efficiency is 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.

## 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:

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 |

## HVAC Efficiencies – Current Code

The minimum efficiencies in this section reflect current NJ energy code requirements. At the time of this writing, NJ energy code is defined by ASHRAE 90.1-2019 (commercial) and IECC 2021 (residential). Note that IECC 2021 Section R403.7 states “New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law.” As such, the values for residential sized equipment are from The Code of Federal Regulations 10 CFR 430.32, 2024. The values for commercial sized equipment, or any equipment not present in the 10 CFR 430.32, are from ASHRAE 90.1-2019.

Table 8‑2 Central AC and Air Source Heat Pumps

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Capacity | Heating Type | Minimum Cooling Efficiency | Minimum Heating Efficiency |
| **Air Source Air Conditioners** | | | |
| < 65,000 Btu/h | All | 13.4 SEER2 | N/A |
| ≥ 65,000 Btu/h and < 135,000 Btu/h | Electric Resistance | 11.2 EER, 14.8 IEER | N/A |
| Other | 11 EER, 14.6 IEER |
| ≥ 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 11 EER, 14.2 IEER | N/A |
| Other | 10.8 EER, 14 IEER |
| ≥ 240,000 Btu/h and < 760,000 Btu/h | Electric Resistance | 10 EER, 13.2 IEER | N/A |
| Other | 9.8 EER, 13 IEER |
|  |  |  |
| ≥ 760,000 Btu/h | Electric Resistance | 9.7 EER, 12.5 IEER | N/A |  |
| Other | 9.5 EER, 12.3 IEER |  |
| **Air Source Heat Pumps** | | | |  |
| < 65,000 Btu/h | All | 14.3 SEER2 (Split), 13.4 SEER2 (Package) | 7.5 HSPF2 (Split), 6.7 HSPF2 (Package) |  |
| ≥ 65,000 Btu/h  and < 135,000 Btu/h | Electric Resistance | 11.0 EER, 14.1 IEER | 3.4 COPH (47F db/43F wb OA) 2.25 COPH (17F db/15F wb OA) |  |
| Other | 10.8 EER, 13.9 IEER |  |
| ≥ 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 10.6 EER, 13.5 IEER | 3.2 COPH (47F db/43F wb OA) 2.05 COPH (17F db/15F wb OA) |  |
| Other | 10.4 EER, 13.3 IEER |  |
| ≥ 240,000 Btu/h | Electric Resistance | 9.5 EER, 12.5 IEER | 3.2 COPH (47F db/43F wb OA) 2.05 COPH (17F db/15F wb OA) |  |
| Other | 9.3 EER, 12.3 IEER |  |
| **Water-cooled air conditioner** | | | |  |
| < 65,000 Btu/h | All | 12.1 EER, 12.3 IEER | N/A |  |
| ≥ 65,000 Btu/h  and < 135,000 Btu/h | Electric Resistance | 12.1 EER, 13.9 IEER | N/A |  |
| Other | 11.9 EER, 13.7 IEER |  |  |
| ≥ 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 12.5 EER, 13.9 IEER | N/A |  |
| Other | 12.3 EER, 13.7 IEER |  |  |
| ≥ 240,000 Btu/h and < 760,000 Btu/h | Electric Resistance | 12.4 EER, 13.6 IEER | N/A |  |
| Other | 12.2 EER, 13.4 IEER |  |  |
| ≥ 760,000 Btu/h | Electric Resistance | 12.2 EER, 13.5 IEER | N/A |  |
| Other | 12.0 EER, 13.3 IEER |  |  |
| **Evaporatively-cooled Air Conditioner** | | | |  |
| < 65,000 Btu/h | All | 12.1 EER, 12.3 IEER | N/A |  |
| ≥ 65,000 Btu/h  and < 135,000 Btu/h | Electric Resistance | 12.1 EER, 12.3 IEER | N/A |  |
| Other | 11.9 EER, 12.1 IEER |  |
| ≥ 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 12.0 EER, 12.2 IEER | N/A |  |
| Other | 11.8 EER, 12.0 IEER |  |
| ≥ 240,000 Btu/h and < 760,000 Btu/h | Electric Resistance | 11.9 EER, 12.1 IEER | N/A |  |
| Other | 11.7 EER, 11.9 IEER |  |
| ≥ 760,000 Btu/h | Electric Resistance | 11.7 EER, 11.9 IEER | N/A |  |
| Other | 11.5 EER, 11.7 IEER |  |

Table 8‑3 Water Source and Ground Source Heat Pumps

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | Size Category | Minimum Cooling Efficiency | Minimum Heating Efficiency |
| Water-to-air, water loop | < 17,000 Btu/h | 12.2 EER | 4.3 COP |
| ≥ 17,000 Btu/h and < 65,000 Btu/h | 13.0 EER | 4.3 COP |
| ≥ 65,000 Btu/h and < 135,000 Btu/h | 13.0 EER | 4.3 COP |
| Water-to-air, ground water | < 135,000 Btu/h | 18.0 EER | 3.7 COP |
| Brine-to-air, ground loop | < 135,000 Btu/h | 14.1 EER | 3.2 COP |
| Water-to-water, water loop | < 135,000 Btu/h | 10.6 EER | 4.3 COP |
| Water-to-water, ground water | < 135,000 Btu/h | 16.3 EER | 3.1 COP |
| Brine-to-water, ground loop | < 135,000 Btu/h | 12.1 EER | 2.5 COP |

Table 8‑4 PTAC, PTHP, SVAC, SVHP

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | Size Category (Input) | Minimum Cooling Efficiency | Minimum Heating Efficiency |
| PTAC (standard size) | < 7,000 Btu/h | 11.9 EER |  |
| ≥ 7,000 Btu/h and ≤ 15,000 Btu/h | 14.0 - (0.300 x Cap/1,000) EER |  |
| > 15,000 Btu/h | 9.5 EER |  |
| PTAC (nonstandard size) | < 7,000 Btu/h | 9.4 EER |  |
| ≥ 7,000 Btu/h and ≤ 15,000 Btu/h | 10.9 - (0.213 x Cap/1,000) EER |  |
| > 15,000 Btu/h | 7.7 EER |  |
| PTHP (standard size) | < 7,000 Btu/h | 11.9 EER | 3.3 COP |
| ≥ 7,000 Btu/h and ≤ 15,000 Btu/h | 14.0 - (0.300 x Cap/1,000) EER | 3.7 - (0.052 x Cap/1,000) COP |
| > 15,000 Btu/h | 9.5 EER | 2.9 COP |
| PTHP (nonstandard size) | < 7,000 Btu/h | 9.3 EER | 2.7 COP |
| ≥ 7,000 Btu/h and ≤ 15,000 Btu/h | 10.8 - (0.213 x Cap/1,000) EER | 2.9 - (0.026 x Cap/1000) COP |
| > 15,000 Btu/h | 7.6 EER | 2.5 COP |
| SPVAC | < 65,000 Btu/h | 11 EER |  |
| ≥ 65,000 Btu/h and < 135,000 Btu/h | 10 EER |  |
| ≥ 135,000 Btu/h and ≤ 240,000 Btu/h | 10.1 EER |  |
| SPVHP | < 65,000 Btu/h | 11 EER | 3.3 COP |
| ≥ 65,000 Btu/h and < 135,000 Btu/h | 10 EER | 3.0 COP |
| ≥ 135,000 Btu/h and ≤ 240,000 Btu/h | 10.1 EER | 3.0 COP |

Table 8‑5 Boilers

|  |  |  |
| --- | --- | --- |
| Boiler Type | Size Category (kBtu input) | Minimum Efficiency |
| Hot Water- Gas Fired | Residential only | 84% AFUE |
| <300 | 82% AFUE |
| ≥300 and ≤ 2,500 | 80% Et |
| >2,500 | 82% Ec |
| Hot Water- Oil Fired | Residential only | 86% AFUE |
| <300 | 84% AFUE |
| ≥300 and ≤ 2,500 | 82% Et |
| >2,500 | 84% Ec |
| Steam- Gas Fired | Residential only | 82% AFUE |
| <300 | 80% AFUE |
| Steam- Gas Fired All except Natural Draft | ≥300 and ≤ 2,500 | 79% Et |
| >2,500 | 79% Et |
| Steam- Gas Fired Natural Draft | ≥300 and ≤ 2,500 | 79% Et |
| >2,500 | 79% Et |
| Steam-Oil Fired | Residential only | 82% AFUE |
| <300 | 82% AFUE |
| ≥300 and ≤ 2,500 | 81% Et |
| >2,500 | 81% Et |

Table 8‑6 Furnaces

|  |  |  |
| --- | --- | --- |
| Equipment Type | Size Category (kBtu input) | Minimum Efficiency |
| Gas Fired Furnace | < 225 | Nonweatherized 80% AFUE |
| Weatherized 81% AFUE |
| Gas Fired Furnace | ≥ 225 | 81% Et |
| Oil Fired Furnace | < 225 | Nonweatherized excluding mobile home: 83% AFUE |
| Nonweatherized mobile home: 75% AFUE |
| Weatherized: 78% AFUE |
| Oil Fired Furnace | ≥ 225 | 82% Et |
| Gas Fired Unit Heaters | All Capacities | 80% Ec |
| Oil Fired Unit Heaters | All Capacities | 80% Ec |

Table 8‑7 Room AC

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Size Category (Btu/h input)** | **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 |

## HVAC Efficiencies – Vintage Code

The minimum efficiencies in this section reflect NJ energy code requirements from approximately 10 years ago. At the time of this writing, NJ energy code is defined by ASHRAE 90.1-2019 (commercial) and IECC 2021 (residential). Note that IECC 2021 Section R403.7 states “New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law.” As such, the values for residential sized equipment are from The Code of Federal Regulations 10 CFR 430.32, 2010. The values for commercial sized equipment, or any equipment not present in the CFR, are from ASHRAE 90.1-2013.

Table 8‑8 Central AC and Air Source Heat Pumps

|  |  |  |  |
| --- | --- | --- | --- |
| **Equipment Type and Capacity** | **Heating Type** | **Minimum Cooling Efficiency** | **Minimum Heating Efficiency** |
| **Air Source Air Conditioners** | | | |
| < 65,000 Btu/h | All | 13 SEER | N/A |
| > 65,000 Btu/h and < 135,000 Btu/h | Electric Resistance | 11.2 EER, 12.9 IEER | N/A |
| Other | 11.0 EER, 12.7 IEER |
| > 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 11.0 EER, 12.4 IEER | N/A |
| Other | 10.8 EER, 12.2 IEER |
| > 240,000 Btu/h and < 760,000 Btu/h | Electric Resistance | 10.0 EER, 11.6 IEER | N/A |
| Other | 9.8 EER, |
| 11.4 IEER |
| > 760,000 Btu/h | Electric Resistance | 9.7 EER, 11.2 IEER | N/A |
| Other | 9.5 EER, 11.0 IEER |
| **Air Source Heat Pumps** | | | |
| < 65,000 Btu/h | All | 14 SEER | 8.2 HSPF (Split), 8.0 HSPF (Package) |
| > 65,000 Btu/h | Electric Resistance | 11 EER, 12.2 IEER | 3.3 COPH (47F db/43F wb OA) 2.25 COPH (17F db/15F wb OA) |
| and < 135,000 Btu/h | Other | 10.8 EER, 12.0 IEER |
| > 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 10.6 EER, 11.6 IEER | 3.2 COPH (47F db/43F wb OA) 2.05 COPH (17F db/15F wb OA) |
| Other | 10.4 EER, 11.4 IEER |
| > 240,000 Btu/h | Electric Resistance | 9.5 EER, 10.6 IEER | 3.2 COPH (47F db/43F wb OA) 2.05 COPH (17F db/15F wb OA) |
| Other | 9.3 EER, 10.4 IEER |
| **Water-cooled air conditioner** | | | |
| < 65,000 Btu/h | All | 12.1 EER, 12.3 IEER | N/A |
| > 65,000 Btu/h | Electric Resistance | 12.1 EER, 13.9 IEER | N/A |
| and < 135,000 Btu/h | Other | 11.9 EER, 13.7 IEER |
| > 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 12.5 EER, 13.9 IEER | N/A |
| Other | 12.3 EER, 13.7 IEER |
| > 240,000 Btu/h and < 760,000 Btu/h | Electric Resistance | 12.4 EER, 13.6 IEER | N/A |
| Other | 12.2 EER, 13.4 IEER |
| > 760,000 Btu/h | Electric Resistance | 12.2 EER, 13.5 IEER | N/A |
| Other | 12.0 EER, 13.3 IEER |
| **Evaporatively-cooled Air Conditioner** | | | |
| < 65,000 Btu/h | All | 12.1 EER, 12.3 IEER | N/A |
| > 65,000 Btu/h | Electric Resistance | 12.1 EER, 12.3 IEER | N/A |
| and < 135,000 Btu/h | Other | 11.9 EER, 12.1 IEER |
| > 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance | 12.0 EER, 12.2 IEER | N/A |
| Other | 11.8 EER, 12.0 IEER |
| > 240,000 Btu/h and < 760,000 Btu/h | Electric Resistance | 11.9 EER, 12.1 IEER | N/A |
| Other | 11.7 EER, 11.9 IEER |
| > 760,000 Btu/h | Electric Resistance | 11.7 EER, 11.9 IEER | N/A |
| Other | 11.5 EER, 11.7 IEER |

Table 8‑9 Water and Ground Source Heat Pump

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | Size Category | Minimum Cooling Efficiency | Minimum Heating Efficiency |
| Water-to-air, water loop | < 17,000 Btu/h | 12.2 EER | 4.3 COP |
| ≥ 17,000 Btu/h and < 65,000 Btu/h | 13.0 EER | 4.3 COP |
| ≥ 65,000 Btu/h and < 135,000 Btu/h | 13.0 EER | 4.3 COP |
| Water-to-air, ground water | < 135,000 Btu/h | 18.0 EER | 3.7 COP |
| Brine-to-air, ground loop | < 135,000 Btu/h | 14.1 EER | 3.2 COP |
| Water-to-water, water loop | < 135,000 Btu/h | 10.6 EER | 3.7 COP |
| Water-to-water, ground water | < 135,000 Btu/h | 16.3 EER | 3.1 COP |
| Brine-to-water, ground loop | < 135,000 Btu/h | 12.1 EER | 2.5 COP |

Table 8‑10 PTAC, PTHP, SPVAC, SVHP

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | Size Category (Input) | Minimum Cooling Efficiency | Minimum Heating Efficiency |
| PTAC | All | 13.8 - (0.30 x Cap/1,000) EER |  |
| PTHP | All | 14 - (0.30 x Cap/1,000) EER | 3.2 - (0.023 x Cap/1,000) COP |
| SPVAC | < 65,000 Btu/h | 9.0 EER |  |
| SVHP | < 65,000 Btu/h | 9.0 EER | 3.0 COP |

Table 8‑11 Boilers

|  |  |  |
| --- | --- | --- |
| Boiler Type | Size Category (kBtu input) | Minimum Efficiency |
| Hot Water- Gas Fired | Residential only | 82% AFUE |
| <300 | 80% AFUE |
| ≥300 and ≤ 2,500 | 80% Et |
| >2,500 | 82% Ec |
| Hot Water- Oil Fired | Residential only | 84% AFUE |
| <300 | 80% AFUE |
| ≥300 and ≤ 2,500 | 82% Et |
| >2,500 | 84% Ec |
| Steam- Gas Fired | Residential only | 80% AFUE |
| <300 | 75% AFUE |
| Steam- Gas Fired All except Natural Draft | ≥300 and ≤ 2,500 | 79% Et |
| >2,500 | 79% Et |
| Steam- Gas Fired Natural Draft | ≥300 and ≤ 2,500 | 77% Et |
| >2,500 | 77% Et |
| Steam-Oil Fired | Residential only | 82% AFUE |
| <300 | 80% AFUE |
| ≥300 and ≤ 2,500 | 81% Et |

Table 8‑12 Furnaces

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Size Category (kBtu input)** | **Minimum Efficiency** |
| Gas Fired Furnace | < 225 | 78% AFUE or 80% Et |
|  |
| Gas Fired Furnace | ≥ 225 | 80% Ec |  |
| Oil Fired Furnace | < 225 | 78% AFUE or 80% Et |  |
|  |
|  |
| Oil Fired Furnace | ≥ 225 | 81% Et |  |
| Gas Fired Unit Heaters | All Capacities | 80% Ec |  |
| Oil Fired Unit Heaters | All Capacities | 80% Ec |  |

Table 8‑13 Room AC

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Size Category (kBtu input)** | **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 |

## Water Heating Efficiencies - Current Code

The minimum efficiencies in this section reflect current NJ energy code requirements. At the time of this writing, NJ energy code is defined by ASHRAE 90.1-2019 (commercial) and IECC 2021 (residential). Note that IECC 2021 Section R403.7 states “New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law.” The values in the table below are the same in the Code of Federal Regulations 10 CFR 430.32(d) 2024 and ASHRAE 90.1-2019.

Table 8‑14 Minimum Uniform Energy Factor (UEF)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Product Class | Rated Storage Volume and Input Rating | First Hour Rating | Draw Pattern | UEF |
| Electric Storage Water Heater | ≥ 20 gal and ≤ 55 gal | < 18 gallons | Very Small |  |
| ≥ 18 and < 51 gallons | Low |  |
| ≥ 51 and < 75 gallons | Medium |  |
| ≥ 75 gallons | High |  |
| > 55 gal and ≤ 120 gal | < 18 gallons | Very Small |  |
| ≥ 18 and < 51 gallons | Low |  |
| ≥ 51 and < 75 gallons | Medium |  |
| ≥ 75 gallons | High |  |
| Gas-Fired Storage Water Heater | ≥ 20 gal and ≤ 55 gal | < 18 gallons | Very Small |  |
| ≥ 18 and < 51 gallons | Low |  |
| ≥ 51 and < 75 gallons | Medium |  |
| ≥ 75 gallons | High |  |
| > 55 gal and ≤ 100 gal | < 18 gallons | Very Small |  |
| ≥ 18 and < 51 gallons | Low |  |
| ≥ 51 and < 75 gallons | Medium |  |
| ≥ 75 gallons | High |  |
| Instantaneous Electric Water Heater | <2 gal | N/A | Very small | 0.91 |
| Low | 0.91 |
| Medium | 0.91 |
| High | 0.92 |
| Instantaneous Gas-Fired Water Heater | <2 gal and >50,000 Btu/h | N/A | Very small | 0.80 |
| Low | 0.81 |
| Medium | 0.81 |
| High | 0.81 |

Vt = rated storage volume in gallons

## Water Heating Efficiencies – Vintage Code

The minimum efficiencies in this section reflect NJ energy code requirements from approximately 10 years ago. At the time of this writing, NJ energy code is defined by ASHRAE 90.1-2019 (commercial) and IECC 2021 (residential). Note that IECC 2021 Section R403.7 states “New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law.” As such, the values for residential equipment are from The Code of Federal Regulations 10 CFR 430.32, 2010 for products manufactured after January 2024 and before April 2015. The values for commercial sized equipment are from ASHRAE 90.1-2013.

Table 8‑15 Residential Minimum Energy Factor (EF)

|  |  |
| --- | --- |
| Product Class | EF |
| Electric Storage Water Heater |  |
| Electric Instantaneous Water Heater |  |
| Gas-Fired Storage Water Heater |  |
| Gas Intantaneous Water Heater |  |
| Oil Storage Water Heater |  |

Vt = rated storage volume in gallons

Table 8‑16 Commercial Minimum Energy Factor (EF)

|  |  |
| --- | --- |
| Product Class | EF |
| Electric Storage Water Heater |  |
| Electric Instantaneous Water Heater | Default to CFR: |
| Gas-Fired Storage Water Heater |  |
| Gas Intantaneous Water Heater |  |
| Oil Storage Water Heater |  |

# 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 |

# 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:[[212]](#footnote-214)

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 |

## 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 |  |
| 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 |
| 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 |
| 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 |
| 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 |  |
| 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 |  |

## 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 |
| 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 |

## 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 |  |
| 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 |
| 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 |
| 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 |

## 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) | 6,136 | 5,588 | 5,529 | 5,658 | 4,795 | 5,553 |
| Gas Peak Day HDD(65) | 66.4 | 66.4 | 66.4 | 66.4 | 66.4 | 66.4 |
| PDF | 0.0108 | 0.0119 | 0.0120 | 0.0117 | 0.0138 | 0.0120 |

## 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 |
| 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 |
| 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 |

# Appendix H: Net-to-Gross Factors

| **IOU** | **Program** | **Subprogram** | **Measure Description** | **NTGR** |
| --- | --- | --- | --- | --- |
| ACE | Energy Efficient Products | Marketplace | Smart Thermostats | 63% |
| ACE | Existing Homes | MI Weatherization | Program | 81% |
| ACE | Existing Homes | QHEC | Program | 71% |
| ETG | Energy Efficient Products | Appliance Rebate | ENERGY STAR Clothes Dryer | 43% |
| ETG | Energy Efficient Products | Appliance Rebate | ENERGY STAR Clothes Washer | 42% |
| ETG | Energy Efficient Products | HVAC | ENERGY STAR Gas Combination Heater | 76% |
| ETG | Energy Efficient Products | HVAC | ENERGY STAR Gas Furnace | 66% |
| ETG | Energy Efficient Products | HVAC | ENERGY STAR Water Heater | 61% |
| ETG | Energy Efficient Products | HVAC | Program | 71% |
| ETG | Energy Efficient Products | Marketplace | High efficiency low flow showerhead | 85% |
| ETG | Energy Efficient Products | Marketplace | Program | 85% |
| ETG | Energy Efficient Products | Marketplace | Smart thermostat | 88% |
| ETG | Existing Homes | MI Weatherization | Air Sealing | 94% |
| ETG | Existing Homes | MI Weatherization | Insulation | 99% |
| ETG | Existing Homes | MI Weatherization | Program | 97% |
| ETG | Existing Homes | QHEC | Low-Flow Showerhead | 89% |
| ETG | Existing Homes | QHEC | Program | 90% |
| JCPL | Any | Multi-Family | Advanced Power Strip | 94% |
| JCPL | Energy Efficient Products | Appliance Recycling | Freezer Recycling | 50% |
| JCPL | Energy Efficient Products | Appliance Recycling | Refrigerator Recycling | 37% |
| JCPL | Energy Efficient Products | HVAC | Air Source Heat Pump - HVAC | 64% |
| JCPL | Energy Efficient Products | HVAC | Central AC – HVAC | 61% |
| JCPL | Energy Efficient Products | HVAC | Smart Thermostats – HVAC | 71% |
| JCPL | Energy Efficient Products | Marketplace | Program | 78% |
| JCPL | Energy Efficient Products | Marketplace | Smart Thermostats – Online Marketplace | 100% |
| JCPL | Energy Solutions for Business |  | Prescriptive Midstream | 73% |
| JCPL | Energy Solutions for Business | Midstream Lighting | Prescriptive Midstream Lighting | 73% |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Prescriptive and Custom | 85% |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Program | 86% |
| JCPL | Existing Homes | HPwES | Envelope | 93% |
| JCPL | Existing Homes | QHEC | APS | 97% |
| JCPL | Existing Homes | QHEC | Showerheads | 100% |
| NJNG | Energy Efficient Products |  | Program | 62% |
| NJNG | Energy Efficient Products | HVAC | Subprogram/pathway | 60% |
| NJNG | Existing Homes | HPwES | Program | 89% |
| NJNG | Existing Homes | MI Weatherization | Program | 93% |
| PSEG | Energy Efficient Products | Downstream Rebates | Clothes Dryer | 63% |
| PSEG | Energy Efficient Products | Downstream Rebates | Clothes Washer | 61% |
| PSEG | Energy Efficient Products | Downstream Rebates | Dishwasher | 43% |
| PSEG | Energy Efficient Products | Downstream Rebates | Refrigerator | 54% |
| PSEG | Energy Efficient Products | Downstream Rebates | Smart thermostat | 71% |
| PSEG | Energy Efficient Products | Downstream Rebates | Water Heater | 65% |
| PSEG | Energy Efficient Products | Marketplace | Advanced Power Strip | 94% |
| PSEG | Energy Efficient Products | Marketplace | Air Quality (Air Purifier, Dehumidifier, Air Conditioner) | 87% |
| PSEG | Energy Efficient Products | Marketplace | Kit (Energy Savings Kit, Electric Savings Kit, Gas Savings Kit, Dual-Fuel Savings Kit and Water Conservation Kit) | 92% |
| PSEG | Energy Efficient Products | Marketplace | Showerhead | 88% |
| PSEG | Energy Efficient Products | Marketplace | Smart thermostat | 91% |
| PSEG | Energy Efficient Products | Welcome Kits | Advanced Power Strip | 55% |
| PSEG | Energy Efficient Products | Welcome Kits | Bathroom Aerator | 85% |
| PSEG | Energy Efficient Products | Welcome Kits | Kitchen Aerator | 79% |
| PSEG | Energy Efficient Products | Welcome Kits | LED Bulb | 58% |
| PSEG | Energy Efficient Products | Welcome Kits | LED Desk Lamp | 71% |
| PSEG | Energy Efficient Products | Welcome Kits | LED Night Light | 67% |
| PSEG | Energy Efficient Products | Welcome Kits | Low Flow Showerhead | 77% |
| PSEG | Existing Homes | HPwES | Air Sealing / Insulation | 91% |
| PSEG | Existing Homes | HPwES | HVAC / Water Heating | 91% |
| PSEG | Existing Homes | HPwES | Program | 91% |
| PSEG | Existing Homes | QHEC | LED | 75% |
| SJG | Energy Efficient Products | Appliance Rebate | ENERGY STAR Clothes Dryer | 43% |
| SJG | Energy Efficient Products | Appliance Rebate | ENERGY STAR Clothes Washer | 42% |
| SJG | Energy Efficient Products | Downstream Rebates | Program | 71% |
| SJG | Energy Efficient Products | HVAC | ENERGY STAR Gas Combination Heater | 76% |
| SJG | Energy Efficient Products | HVAC | ENERGY STAR Gas Furnace | 66% |
| SJG | Energy Efficient Products | HVAC | ENERGY STAR Water Heater | 61% |
| SJG | Energy Efficient Products | Marketplace | Low-Flow Showerheads | 85% |
| SJG | Energy Efficient Products | Marketplace | Program | 85% |
| SJG | Energy Efficient Products | Marketplace | Smart Thermostats | 88% |
| SJG | Existing Homes | MI Weatherization | Air Sealing | 95% |
| SJG | Existing Homes | MI Weatherization | Duct Improvements | 99% |
| SJG | Existing Homes | MI Weatherization | Insulation | 98% |
| SJG | Existing Homes | MI Weatherization | Program | 98% |
| SJG | Existing Homes | QHEC | Bathroom Faucet Aerator | 102% |
| SJG | Existing Homes | QHEC | Kitchen Faucet Aerator | 102% |
| SJG | Existing Homes | QHEC | Low-Flow Showerhead | 104% |
| SJG | Existing Homes | QHEC | Pipe Insulation | 104% |
| SJG | Existing Homes | QHEC | Program | 104% |
| SJG | Existing Homes | QHEC | Thermostatic Valve | 102% |

# 

# Appendix I: Realization Rates

| **Utility** | **Program** | **Subprogram** | **Measure Description** | **kWh RR (net of ISR)** | **kW RR (net of ISR)** | **therm RR (net of ISR)** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ACE | Energy Efficient Products | Marketplace | Smart Thermostats | 97% | 100% | 99% | Revision required |
| ACE | Energy Solutions for Business | Energy Management | Building Operator Certification | 100% | 100% | 100% |  |
| ACE | Energy Solutions for Business | SBDI | LED Lighting | 90% | 107% | 90% | Statewide Analysis TBD |
| ACE | Existing Homes | MI Weatherization | Smart Strips | 95% | 100% |  | Statewide Analysis TBD |
| ACE | Existing Homes | MI Weatherization | Water Heater Setbacks | 100% | 100% | 100% |  |
| ACE | Existing Homes | Multi-Family | Advanced Power Strip | 90% | 90% |  | Statewide Analysis TBD |
| ACE | Existing Homes | Multi-Family | Program | 97% | 98% | 82% |  |
| ACE | Existing Homes | Multi-Family | ShowerStart Adapter | 100% | 100% | 134% |  |
| ACE | Existing Homes | QHEC | Program | 90% | 90% | 55% |  |
| ACE | Existing Homes | QHEC | Smart Strips | 88% | 88% |  | Statewide Analysis TBD |
| ACE | Existing Homes | QHEC | Smart Thermostats | 76% |  | 76% | Revision required |
| ETG | Energy Efficient Products | Downstream Rebates | Clothes Washers | 103% | 103% | 106% | Revision required |
| ETG | Energy Efficient Products | Downstream Rebates | Gas Combination Heaters |  |  | 92% |  |
| ETG | Energy Efficient Products | Downstream Rebates | Gas Storage Tank Water Heaters |  |  | 101% | Revision required |
| ETG | Energy Efficient Products | Downstream Rebates | Program | 91% | 54% | 105% |  |
| ETG | Energy Efficient Products | Downstream Rebates | Tankless Water Heaters |  |  | 97% | Revision required |
| ETG | Energy Efficient Products | Online Marketplace | Program | 97% |  | 97% |  |
| ETG | Energy Efficient Products | Online Marketplace | Smart Thermostat | 97% |  | 97% | Revision required |
| ETG | Existing Homes | Multi-Family | Program |  |  | 98% |  |
| ETG | Existing Homes | QHEC | Program | 187% | 128% | 94% |  |
| ETG | Existing Homes | QHEC | Smart Power Strips | 100% | 75% |  | Statewide Analysis TBD |
| JCPL | Any | Multi-Family | Advanced Power Strip - Enhanced Rigor - Monitoring Study | 31% | 49% |  | Statewide Analysis TBD |
| JCPL | Energy Efficient Products | Appliance Recycling | Room Air Conditioner Recycling | 100% | 100% | 100% |  |
| JCPL | Energy Efficient Products | Online Marketplace | Advanced Power Strip | 100% | 100% | 100% | Statewide Analysis TBD |
| JCPL | Energy Efficient Products | Online Marketplace | Air Purifier - Enhanced Rigor | 28% | 109% | 100% |  |
| JCPL | Energy Efficient Products | Online Marketplace | Smart Thermostat - Basic Rigor | 100% | 100% | 100% | Revision required |
| JCPL | Energy Efficient Products | Upstream | Dehumidifier | 100% | 100% | 100% |  |
| JCPL | Energy Efficient Products | Upstream | Room Air Conditioner | 100% | 100% | 100% |  |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Chiller | 102% | 101% | 100% |  |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Lighting | 94% | 93% | 128% | Statewide Analysis TBD |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Midstream Lighting | 91% | 86% | 88% | Statewide Analysis TBD |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Program | 94% | 92% | 111% |  |
| JCPL | Energy Solutions for Business | SBDI | Prescriptive Lighting | 86% | 92% |  | Statewide Analysis TBD |
| JCPL | Energy Solutions for Business | SBDI | Program | 80% | 78% |  |  |
| JCPL | Existing Homes | MI Weatherization | Advanced Power Strip - Enhanced Rigor - Monitoring Study | 31% | 49% |  | Statewide Analysis TBD |
| JCPL | Existing Homes | QHEC | Advanced Power Strip - Enhanced Rigor - Monitoring Study | 31% | 49% |  | Statewide Analysis TBD |
| NJNG | Energy Efficient Products |  | Program | 97% | 99% | 98% |  |
| NJNG | Energy Efficient Products | Online Marketplace | Thermostats | 91% |  | 86% | Revision required |
| NJNG | Energy Efficient Products | Washer/Dryer | ENERGY STAR Clothes Washer |  |  | 178% | Revision required |
| NJNG | Energy Solutions for Business | Prescriptive/Custom | Program |  |  | 100% |  |
| NJNG | Energy Solutions for Business | SBDI | Program | 100% |  | 100% |  |
| NJNG | Existing Homes | MI Weatherization | Powerstrip | 100% |  |  | Statewide Analysis TBD |
| NJNG | Existing Homes | MI Weatherization | Program | 88% |  | 96% |  |
| NJNG | Existing Homes | QHEC | Advanced Power Strip | 85% | 85% |  | Statewide Analysis TBD |
| NJNG | Existing Homes | QHEC | Program | 83% | 85% | 78% |  |
| PSEG | Energy Efficient Products | Appliance Instant Rebate | Dishwasher | 80% |  |  |  |
| PSEG | Energy Efficient Products | Appliance Instant Rebate | Gas Storage Tank Water Heater |  |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Appliance Instant Rebate | Instantaneous Water Heaters |  |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Appliance Instant Rebate | Smart Thermostat | 119% |  | 112% | Revision required |
| PSEG | Energy Efficient Products | Appliance Recycling | Room AC Recycling | 100% |  |  |  |
| PSEG | Energy Efficient Products | Downstream Rebates | Dishwasher | 80% | 80% | 36% |  |
| PSEG | Energy Efficient Products | Downstream Rebates | ENERGY STAR Clothes Washer | 100% | 100% | 100% | Revision required |
| PSEG | Energy Efficient Products | Downstream Rebates | ENERGY STAR Refrigerators | 100% | 100% |  |  |
| PSEG | Energy Efficient Products | Downstream Rebates | Gas Storage Tank Water Heater |  |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Downstream Rebates | Instantaneous Water Heaters |  |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Downstream Rebates | Smart Thermostat | 100% |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Marketplace | Advanced Power Strip | 100% | 100% |  | Statewide Analysis TBD |
| PSEG | Energy Efficient Products | Marketplace | Air Quality - Air Purifier | 96% | 96% |  |  |
| PSEG | Energy Efficient Products | Marketplace | Air Quality - Dehumidifier | 100% | 100% |  |  |
| PSEG | Energy Efficient Products | Marketplace | Air Quality- Air Conditioner | 95% | 95% |  |  |
| PSEG | Energy Efficient Products | Marketplace | Thermostat | 100% |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Marketplace | Thermostat (Offer Center) | 100% |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Midstream HVAC | Boiler Reset Controls |  |  | 100% |  |
| PSEG | Energy Efficient Products | Midstream HVAC | Furnace Fans (ECM motor install) | 100% | 100% |  |  |
| PSEG | Energy Efficient Products | Midstream HVAC | Gas Boiler |  |  | 100% |  |
| PSEG | Energy Efficient Products | Midstream HVAC | Gas Combination Boiler |  |  | 95% | Revision required |
| PSEG | Energy Efficient Products | Midstream HVAC | Gas Storage Water Heater |  |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Midstream HVAC | Instantaneous Water Heaters |  |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Midstream HVAC | Smart Thermostat | 100% |  | 100% | Revision required |
| PSEG | Energy Efficient Products | Midstream Markdown | Advanced Power Strips - Nonprofit | 100% | 86% |  | Statewide Analysis TBD |
| PSEG | Energy Efficient Products | Midstream Markdown | Advanced Power Strips - Retail | 100% | 100% |  | Statewide Analysis TBD |
| PSEG | Energy Efficient Products | Midstream Markdown | ENERGY STAR Dehumidifier | 100% | 100% |  |  |
| PSEG | Energy Efficient Products | Midstream Markdown | ENERGY STAR Room AC | 179% | 179% |  |  |
| PSEG | Energy Efficient Products | Midstream Markdown | ENERGY STAR Room Air Purifier | 95% | 55% |  |  |
| PSEG | Energy Efficient Products | Midstream Markdown | High-Efficiency Bathroom Exhaust Fan | 100% | 101% |  |  |
| PSEG | Energy Solutions for Business | Prescriptive/Custom | Custom - Program | 115% | 104% | 91% |  |
| PSEG | Energy Solutions for Business | Prescriptive/Custom | Midstream - Lighting | 102% | 102% |  | Statewide Analysis TBD |
| PSEG | Energy Solutions for Business | Prescriptive/Custom | Prescriptive - Lighting | 92% | 109% |  | Statewide Analysis TBD |
| PSEG | Energy Solutions for Business | SBDI | Non UEZ - Demand Controlled Ventilation | 100% | 100% | 100% |  |
| PSEG | Energy Solutions for Business | SBDI | Non UEZ - Lighting | 101% | 102% | 128% | Statewide Analysis TBD |
| PSEG | Energy Solutions for Business | SBDI | UEZ - Boilers |  |  | 90% |  |
| PSEG | Energy Solutions for Business | SBDI | UEZ - Demand Controlled Ventilation | 100% | 100% | 101% |  |
| PSEG | Energy Solutions for Business | SBDI | UEZ - Lighting | 96% | 95% | 88% | Statewide Analysis TBD |
| PSEG | Energy Solutions for Business | SBDI | UEZ - Pipe Insulation |  |  | 99% | Revision required |
| PSEG | Existing Homes | HPwES | Whole building | 100% |  | 70% |  |
| PSEG | Existing Homes | MI Weatherization | Smart Strip | 100% | 100% |  | Statewide Analysis TBD |
| PSEG | Existing Homes | MI Weatherization | Whole building | 99% |  | 78% |  |
| PSEG | Existing Homes | Multi-Family | ShowerStart Showerhead Adapter | 102% | 74% | 75% |  |
| PSEG | Existing Homes | Multi-Family | Smart Strip | 104% | 104% |  | Statewide Analysis TBD |
| PSEG | Existing Homes | QHEC | Smart Strip | 100% | 100% |  | Statewide Analysis TBD |
| SJG | Energy Efficient Products | Downstream Rebates | Clothes Washers | 99% | 99% | 126% | Revision required |
| SJG | Energy Efficient Products | Downstream Rebates | Gas Combination Heaters |  |  | 88% | Revision required |
| SJG | Energy Efficient Products | Downstream Rebates | Gas Storage Tank Water Heaters |  |  | 96% | Revision required |
| SJG | Energy Efficient Products | Downstream Rebates | Program | 84% | 52% | 86% |  |
| SJG | Energy Efficient Products | Downstream Rebates | Tankless Water Heaters |  |  | 103% | Revision required |
| SJG | Energy Efficient Products | Online Marketplace | Program | 92% |  | 97% |  |
| SJG | Energy Efficient Products | Online Marketplace | Smart Thermostat | 100% |  | 100% | Revision required |
| SJG | Energy Solutions for Business | Prescriptive/Custom | Program |  |  | 92% |  |
| SJG | Energy Solutions for Business | SBDI | Prescriptive Lighting - Interior | 100% | 131% | 108% | Statewide Analysis TBD |
| SJG | Energy Solutions for Business | SBDI | Program | 141% | 132% | 115% |  |
| SJG | Existing Homes | HER | Program |  |  | 84% |  |
| SJG | Existing Homes | MI Weatherization | Duct Sealing\* | 57% |  | 54% |  |
| SJG | Existing Homes | MI Weatherization | Tune-up | 57% |  | 54% |  |
| SJG | Existing Homes | MI Weatherization | Whole building | 57% |  | 54% |  |
| SJG | Existing Homes | Multi-Family | Program | 102% | 100% | 97% |  |
| SJG | Existing Homes | QHEC | Program | 530% | 158% | 146% |  |
| SJG | Existing Homes | QHEC | Smart Power Strips | 100% | 94% |  | Statewide Analysis TBD |
| SJG | Existing Homes | QHEC | Thermostatic Valves |  |  | 82% |  |

# 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.

| **Utility** | **Program** | **Subprogram** | **Measure Description** | **ISR (%)** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| ACE | Energy Efficient Products | Welcome Kits | Advanced Power Strips | 79% | Revision needed |
| ACE | Energy Efficient Products | Welcome Kits | Outlet & Switch Gaskets | 48% | Revision needed |
| ACE | Energy Efficient Products | Welcome Kits | Spray Foam | 36% | Revision needed |
| ACE | Energy Efficient Products | Welcome Kits | Weather Stripping | 38% | Revision needed |
| ACE | Energy Solutions for Business | SBDI | All | 90% |  |
| ACE | Energy Solutions for Business | SBDI | Efficient Lighting/Lighting Controls | 90% |  |
| ACE | Energy Solutions for Business | SBDI | HVAC Equipment | 87% |  |
| ACE | Existing Homes | HPwES | Air Sealing & Insulation | 99% |  |
| ACE | Existing Homes | HPwES | All | 100% |  |
| ACE | Existing Homes | MI Weatherization | All | 94% |  |
| ACE | Existing Homes | MI Weatherization | DHW Equipment | 95% |  |
| ACE | Existing Homes | MI Weatherization | LED Lighting | 95% |  |
| ACE | Existing Homes | MI Weatherization | Pipe Insulation | 83% |  |
| ACE | Existing Homes | MI Weatherization | Smart Power Strip | 96% |  |
| ACE | Existing Homes | QHEC | All | 89% |  |
| ACE | Existing Homes | QHEC | Efficient Showerhead | 88% |  |
| ACE | Existing Homes | QHEC | LED Lighting | 91% |  |
| ACE | Existing Homes | QHEC | Smart Strip | 88% |  |
| ETG | Energy Efficient Products | Marketplace | Smart thermostat | 92% |  |
| ETG | Existing Homes | QHEC | Bathroom Faucet Aerators | 91% |  |
| ETG | Existing Homes | QHEC | LEDs | 80% |  |
| ETG | Existing Homes | QHEC | Low-Flow Showerheads | 79% |  |
| ETG | Existing Homes | QHEC | Smart Power Strips | 75% |  |
| JCPL | Any | Multi-Family | Advanced Power Strip | 79% |  |
| JCPL | Any | Multi-Family | Air Source Heat Pump | 100% |  |
| JCPL | Any | Multi-Family | Faucet Aerator | 100% |  |
| JCPL | Any | Multi-Family | Holiday Lights | 100% |  |
| JCPL | Any | Multi-Family | LED Bulb | 95% |  |
| JCPL | Any | Multi-Family | LED Nightlight | 100% |  |
| JCPL | Any | Multi-Family | Minisplit Heat Pump | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Air Purifier | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Clothes Dryer | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Clothes Washer | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Dehumidifier | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Heat Pump Water Heater | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Refrigerator | 100% |  |
| JCPL | Energy Efficient Products | Downstream Rebates | Room Air Conditioner | 100% |  |
| JCPL | Energy Efficient Products | HVAC | ASHP | 100% |  |
| JCPL | Energy Efficient Products | HVAC | CAC | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Ductless Mini-Split | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Furnace | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Furnace Fan | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Gas Furnace and Water Heater | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Gas Heat | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Gas Water Heater | 100% |  |
| JCPL | Energy Efficient Products | HVAC | GSHP | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Heat Pump Water Heater | 100% |  |
| JCPL | Energy Efficient Products | HVAC | Smart Thermostat | 100% |  |
| JCPL | Energy Efficient Products | Online Marketplace | Air Purifier - Basic Rigor | 100% |  |
| JCPL | Energy Efficient Products | Online Marketplace | Smart Thermostat - Basic Rigor | 87% |  |
| JCPL | Energy Efficient Products | Upstream | Dehumidifier | 100% |  |
| JCPL | Energy Efficient Products | Upstream | Room Air Conditioner | 100% |  |
| JCPL | Energy Solutions for Business | Prescriptive/Custom | Downstream/Midstream Lighting | 98% |  |
| JCPL | Energy Solutions for Business | SBDI | Door Gasket | 106% |  |
| JCPL | Energy Solutions for Business | SBDI | Lighting | 100% |  |
| JCPL | Energy Solutions for Business | SBDI | Night covers | 91% |  |
| JCPL | Energy Solutions for Business | SBDI | Strip Curtain | 92% |  |
| JCPL | Existing Homes | HPwES | Air Sealing | 100% |  |
| JCPL | Existing Homes | HPwES | ASHP | 100% |  |
| JCPL | Existing Homes | HPwES | CAC | 100% |  |
| JCPL | Existing Homes | HPwES | Duct Change | 100% |  |
| JCPL | Existing Homes | HPwES | Duct Insulation | 100% |  |
| JCPL | Existing Homes | HPwES | Duct Sealing | 100% |  |
| JCPL | Existing Homes | HPwES | Furnace | 100% |  |
| JCPL | Existing Homes | HPwES | Gas Boiler | 100% |  |
| JCPL | Existing Homes | HPwES | Gas Water Heater | 100% |  |
| JCPL | Existing Homes | HPwES | HPWH | 100% |  |
| JCPL | Existing Homes | HPwES | Insulation | 100% |  |
| JCPL | Existing Homes | HPwES | Minisplit | 100% |  |
| JCPL | Existing Homes | HPwES | Program - Enhanced | 100% |  |
| JCPL | Existing Homes | HPwES | Program - Enhanced | 100% |  |
| JCPL | Existing Homes | HPwES | Smart Thermostat | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Advanced Power Strip | 87% |  |
| JCPL | Existing Homes | MI Weatherization | Advanced Power Strip - Enhanced Rigor | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Advanced Power Strip - Enhanced Rigor | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Air Sealing | 100% |  |
| JCPL | Existing Homes | MI Weatherization | DHW Setback | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Duct Insulation | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Duct Sealing | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Faucet Aerator | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Insulation | 100% |  |
| JCPL | Existing Homes | MI Weatherization | LED Bulb | 100% |  |
| JCPL | Existing Homes | MI Weatherization | LED Nightlight | 100% |  |
| JCPL | Existing Homes | MI Weatherization | Showerhead | 100% |  |
| JCPL | Existing Homes | QHEC | Advanced Power Strip | 83% |  |
| JCPL | Existing Homes | QHEC | Advanced Power Strip - Enhanced Rigor | 100% |  |
| JCPL | Existing Homes | QHEC | Advanced Power Strip - Enhanced Rigor | 100% |  |
| JCPL | Existing Homes | QHEC | DHW Setback | 100% |  |
| JCPL | Existing Homes | QHEC | Faucet Aerator | 100% |  |
| JCPL | Existing Homes | QHEC | Furnace Whistle | 100% |  |
| JCPL | Existing Homes | QHEC | LED Bulb | 97% |  |
| JCPL | Existing Homes | QHEC | LED Nightlight | 100% |  |
| JCPL | Existing Homes | QHEC | Showerhead | 92% |  |
| NJNG | Energy Efficient Products |  | Program | 96% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Air Source Heat Pump | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Boiler | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Central Air Conditioner | 98% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Combination Boiler | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Ductless Mini-Split Heat Pump | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Furnace | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Gas Storage Tank Power Vented Water Heater | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Indirect - Fired Storage Tank Water Heater | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Instantaneous Water Heaters | 100% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Smart Thermostat - Gas heat w/CAC | 87% | Revision needed |
| NJNG | Energy Efficient Products | HVAC | Subprogram/pathway | 99% | Revision needed |
| NJNG | Energy Efficient Products | Online Marketplace | Subprogram/pathway | 87% | Revision needed |
| NJNG | Energy Efficient Products | Online Marketplace | Thermostats | 86% | Revision needed |
| NJNG | Energy Efficient Products | Washer/Dryer | ENERGY STAR Clothes Washer | 97% | Revision needed |
| NJNG | Energy Efficient Products | Washer/Dryer | ENERGY STAR Gas Clothes Dryer | 97% | Revision needed |
| NJNG | Energy Efficient Products | Washer/Dryer | Subprogram/pathway | 97% | Revision needed |
| NJNG | Energy Solutions for Business | Prescriptive/Custom | Program | 100% | Revision needed |
| NJNG | Existing Homes | HPwES | Air Sealing and Insulation | 99% | Revision needed |
| NJNG | Existing Homes | HPwES | All | 96% | Revision needed |
| NJNG | Existing Homes | HPwES | Cooling System | 99% | Revision needed |
| NJNG | Existing Homes | HPwES | Duct Sealing | 79% | Revision needed |
| NJNG | Existing Homes | HPwES | Heating System | 98% | Revision needed |
| NJNG | Existing Homes | MI Weatherization | Air Sealing & Insulation | 98% | Revision needed |
| NJNG | Existing Homes | MI Weatherization | Seal/Insulate Ductwork | 90% | Revision needed |
| NJNG | Existing Homes | QHEC | Advanced Power Strip | 85% | Revision needed |
| NJNG | Existing Homes | QHEC | Low-flow aerator | 100% | Revision needed |
| NJNG | Existing Homes | QHEC | Low-flow showerhead | 100% | Revision needed |
| NJNG | Existing Homes | QHEC | Outlet gasket | 69% | Revision needed |
| NJNG | Existing Homes | QHEC | Program- Electric Measures | 80% | Revision needed |
| NJNG | Existing Homes | QHEC | Program- Gas Measures | 74% | Revision needed |
| NJNG | Existing Homes | QHEC | Water heater set to 120°F | 79% | Revision needed |
| PSEG | Energy Efficient Products | Downstream Rebates | ENERGY STAR Clothes Washer | 100% |  |
| PSEG | Energy Efficient Products | Downstream Rebates | ENERGY STAR Gas Clothes Dryer | 100% |  |
| PSEG | Energy Efficient Products | Downstream Rebates | ENERGY STAR Refrigerators | 99% |  |
| PSEG | Energy Efficient Products | Downstream Rebates | Smart thermostat | 99% |  |
| PSEG | Energy Efficient Products | Downstream Rebates | Water heater | 100% |  |
| PSEG | Energy Efficient Products | Marketplace | Advance Power Strip | 87% |  |
| PSEG | Energy Efficient Products | Marketplace | Air purifier | 98% |  |
| PSEG | Energy Efficient Products | Marketplace | Dehumidifier | 100% |  |
| PSEG | Energy Efficient Products | Marketplace | Low-Flow Shower Head | 79% |  |
| PSEG | Energy Efficient Products | Marketplace | Smart thermostat | 69% |  |
| PSEG | Energy Efficient Products | Marketplace | Window Air Conditioner | 100% |  |
| PSEG | Energy Efficient Products | Welcome Kits | Advanced Power Strip | 83% |  |
| PSEG | Energy Efficient Products | Welcome Kits | ENERGY STAR certified desk lamp | 79% |  |
| PSEG | Energy Efficient Products | Welcome Kits | Night light | 77% |  |
| PSEG | Existing Homes | MI Weatherization | Faucet Aerator | 91% |  |
| PSEG | Existing Homes | MI Weatherization | LED Reflector | 95% |  |
| PSEG | Existing Homes | MI Weatherization | LED Specialty | 95% |  |
| PSEG | Existing Homes | MI Weatherization | LED Standard | 95% |  |
| PSEG | Existing Homes | MI Weatherization | Low-Flow Showerhead | 100% |  |
| PSEG | Existing Homes | MI Weatherization | ShowerStart | 83% |  |
| PSEG | Existing Homes | MI Weatherization | Smart Strip | 91% |  |
| PSEG | Existing Homes | MI Weatherization | Water Heater Setback | 49% |  |
| PSEG | Existing Homes | Multi-Family | Faucet Aerator | 89% |  |
| PSEG | Existing Homes | Multi-Family | Lighting | 94% |  |
| PSEG | Existing Homes | Multi-Family | Low-Flow Showerhead | 85% |  |
| PSEG | Existing Homes | Multi-Family | Smart Strips | 85% |  |
| PSEG | Existing Homes | QHEC | Faucet Aerator | 89% |  |
| PSEG | Existing Homes | QHEC | LED Reflector | 97% |  |
| PSEG | Existing Homes | QHEC | LED Specialty | 97% |  |
| PSEG | Existing Homes | QHEC | LED Standard | 97% |  |
| PSEG | Existing Homes | QHEC | Low-Flow Showerhead | 75% |  |
| PSEG | Existing Homes | QHEC | Pipe Insulation | 100% |  |
| PSEG | Existing Homes | QHEC | ShowerStart | 92% |  |
| PSEG | Existing Homes | QHEC | Smart Strip | 86% |  |
| PSEG | Existing Homes | QHEC | Smart thermostat | 100% |  |
| SJG | Energy Efficient Products | Marketplace | Smart thermostat | 92% |  |
| SJG | Existing Homes | QHEC | Bathroom Faucet Aerators | 99% |  |
| SJG | Existing Homes | QHEC | Kitchen Faucet Aerators | 100% |  |
| SJG | Existing Homes | QHEC | LEDs | 94% |  |
| SJG | Existing Homes | QHEC | Low-Flow Showerheads | 99% |  |
| SJG | Existing Homes | QHEC | Pipe Insulation | 95% |  |
| SJG | Existing Homes | QHEC | Thermostatic Valve | 91% |  |

# 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

| **Utility** | **Program** | **Subprogram** | **Sector** | **Measure Description** | **Parameter** | **Parameter value** |
| --- | --- | --- | --- | --- | --- | --- |
| ETG | Any | Non-Participant | Residential | Any | % gas water heat | 73% |
| ETG | Any | Non-Participant | Residential | Any | % elec water heat | 9% |
| ETG | Any | Non-Participant | Residential | Any | % gas space heat | 81% |
| ETG | Any | Non-Participant | Residential | Any | % elec space heat | 16% |
| ETG | Energy Efficient Products | Down-stream | Residential | Any | % gas water heat | 93% |
| ETG | Energy Efficient Products | Down-stream | Residential | Any | % elec water heat | 3% |
| ETG | Energy Efficient Products | Down-stream | Residential | Any | % gas space heat | 88% |
| ETG | Energy Efficient Products | Down-stream | Residential | Any | % elec space heat | 8% |
| ETG | Energy Efficient Products | Marketplace | Residential | Any | % gas water heat | 87% |
| ETG | Energy Efficient Products | Marketplace | Residential | Any | % elec water heat | 6% |
| ETG | Energy Efficient Products | Marketplace | Residential | Any | % gas space heat | 88% |
| ETG | Energy Efficient Products | Marketplace | Residential | Any | % elec space heat | 8% |
| ETG | Existing Homes | HER | Residential | Any | % gas water heat | 93% |
| ETG | Existing Homes | HER | Residential | Any | % elec water heat | 6% |
| ETG | Existing Homes | HER | Residential | Any | % gas space heat | 92% |
| ETG | Existing Homes | HER | Residential | Any | % elec space heat | 8% |
| ETG | Existing Homes | HER | Residential | Control Group | % gas water heat | 88% |
| ETG | Existing Homes | HER | Residential | Control Group | % elec water heat | 10% |
| ETG | Existing Homes | HER | Residential | Control Group | % gas water heat | 90% |
| ETG | Existing Homes | HER | Residential | Control Group | % elec water heat | 7% |
| ETG | Existing Homes | QHEC | Residential | Any | % gas water heat | 88% |
| ETG | Existing Homes | QHEC | Residential | Any | % elec water heat | 8% |
| ETG | Existing Homes | QHEC | Residential | Any | % gas space heat | 91% |
| ETG | Existing Homes | QHEC | Residential | Any | % elec space heat | 8% |
| JCPL | Energy Efficient Products | Appliance Rebates | Residential | Clothes Washer | % elec water heat | 91% |
| SJG | Any | Non-Participant | Residential | Any | % elec space heat | 10% |
| SJG | Existing Homes | QHEC | Residential | Any | % gas water heat | 82% |
| SJG | Existing Homes | QHEC | Residential | Any | % elec water heat | 13% |
| SJG | Existing Homes | QHEC | Residential | Any | % gas space heat | 91% |
| SJG | Existing Homes | QHEC | Residential | Any | % elec space heat | 6% |
| SJG | Any | Non-Participant | Residential | Any | % gas water heat | 75% |
| SJG | Any | Non-Participant | Residential | Any | % elec water heat | 16% |
| SJG | Any | Non-Participant | Residential | Any | % gas space heat | 86% |
| SJG | Energy Efficient Products | Down-stream | Residential | Any | % gas water heat | 92% |
| SJG | Energy Efficient Products | Down-stream | Residential | Any | % elec water heat | 6% |
| SJG | Energy Efficient Products | Down-stream | Residential | Any | % gas space heat | 87% |
| SJG | Energy Efficient Products | Down-stream | Residential | Any | % elec space heat | 10% |
| SJG | Energy Efficient Products | Marketplace | Residential | Any | % gas water heat | 83% |
| SJG | Energy Efficient Products | Marketplace | Residential | Any | % elec water heat | 16% |
| SJG | Energy Efficient Products | Marketplace | Residential | Any | % gas space heat | 93% |
| SJG | Energy Efficient Products | Marketplace | Residential | Any | % elec space heat | 6% |
| SJG | Existing Homes | HER | Residential | Any | % gas water heat | 92% |
| SJG | Existing Homes | HER | Residential | Any | % elec water heat | 5% |
| SJG | Existing Homes | HER | Residential | Any | % gas space heat | 93% |
| SJG | Existing Homes | HER | Residential | Any | % elec space heat | 7% |
| SJG | Existing Homes | HER | Residential | Control Group | % gas water heat | 83% |
| SJG | Existing Homes | HER | Residential | Control Group | % elec water heat | 14% |
| SJG | Existing Homes | HER | Residential | Control Group | % gas water heat | 93% |
| SJG | Existing Homes | HER | Residential | Control Group | % elec water heat | 6% |

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 |

# Appendix L: Lighting Wattages

## 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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Measure Name | Min Lumen | Max Lumen | | Baseline Wattage | |
| Energy Star LED Bulb - A Lamp 250-449 Lumens | 250 | 449 | | 25 | |
| Energy Star LED Bulb - A Lamp 450-799 Lumens | 450 | 799 | | 29 | |
| Energy Star LED Bulb - A Lamp 800-1099 Lumens | 800 | 1099 | | 43 | |
| Energy Star LED Bulb - A Lamp 1100-1599 Lumens | 1100 | 1599 | | 53 | |
| Energy Star LED Bulb - A Lamp 1600-1999 Lumens | 1600 | 1999 | | 72 | |
| Energy Star LED Bulb - A Lamp 2000-2549 Lumens | 2000 | 2549 | | 125 | |
| Energy Star LED Bulb - A Lamp 2500-3000 Lumens | 2550 | 3000 | | 150 | |
| Energy Star LED Bulb - A Lamp 3001-3999 Lumens | 3001 | 3999 | | 200 | |
| Energy Star LED Bulb - A Lamp 4000-6000 Lumens | 4000 | 6000 | | 300 | |
| Energy Star LED Bulb - G30 250-349 Lumens | 250 | 349 | | 0 | |
| Energy Star LED Bulb - G30 350-499 Lumens | 350 | 499 | | 0 | |
| Energy Star LED Bulb - G30 500-574 Lumens | 500 | 574 | | 43 | |
| Energy Star LED Bulb - G30 575-649 Lumens | 575 | 649 | | 53 | |
| Energy Star LED Bulb - G30 650-1099 Lumens | 650 | 1099 | | 72 | |
| Energy Star LED Bulb - G30 1100-1300 Lumens | 1100 | 1300 | | 150 | |
| Energy Star LED Bulb - G40 250-349 Lumens | 250 | 349 | | 0 | |
| Energy Star LED Bulb - G40 350-499 Lumens | 350 | 499 | | 0 | |
| Energy Star LED Bulb - G40 500-574 Lumens | 500 | 574 | | 43 | |
| Energy Star LED Bulb - G40 575-649 Lumens | 575 | 649 | | 53 | |
| Energy Star LED Bulb - G40 650-1099 Lumens | 650 | 1099 | | 72 | |
| Energy Star LED Bulb - G40 1100-1300 Lumens | 1100 | 1300 | | 150 | |
| Energy Star LED Bulb - PAR30 220-299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - PAR30 300-599 Lumens | 300 | 599 | | 40 | |
| Energy Star LED Bulb - PAR30 600-849 Lumens | 600 | 849 | | 50 | |
| Energy Star LED Bulb - PAR30 850-999 Lumens | 850 | 999 | | 55 | |
| Energy Star LED Bulb - PAR30 1000-1300 Lumens | 1000 | 1300 | | 65 | |
| Energy Star LED Bulb - PAR30 1400-1599 Lumens | 1400 | 1599 | | 120 | |
| Energy Star LED Bulb - PAR30 1600-2099 Lumens | 1600 | 2099 | | 150 | |
| Energy Star LED Bulb - PAR30 ≥2100 Lumens | 2100 | ∞ | | 250 | |
| Now Inactive |  |  | |  | |
| Now Inactive |  |  | |  | |
| Energy Star LED Bulb - PAR40 |  |  | |  | |
| Energy Star LED Bulb - R30 |  |  | |  | |
| Energy Star LED Bulb - BR30 200-299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - BR30 300-449 Lumens | 300 | 499 | | 40 | |
| Energy Star LED Bulb - BR30 450-499 Lumens | 450 | 499 | | 45 | |
| Energy Star LED Bulb - BR30 500-1419 Lumens | 500 | 1419 | | 65 | |
| Energy Star LED Bulb - BR40 200-299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - BR40 300-449 Lumens | 300 | 449 | | 40 | |
| Energy Star LED Bulb - BR40 450-499 Lumens | 450 | 499 | | 45 | |
| Energy Star LED Bulb - BR40 500-1419 Lumens | 500 | 1419 | | 65 | |
| Energy Star LED Bulb - R14 200 - 299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - R14 300 - 599 Lumens | 300 | 599 | | 40 | |
| Energy Star LED Bulb - R14 600 - 849 Lumens | 600 | 849 | | 50 | |
| Energy Star LED Bulb - R14 850 - 999 Lumens | 850 | 999 | | 55 | |
| Energy Star LED Bulb - R14 1000 - 1300 Lumens | 1000 | 11300 | | 65 | |
| Energy Star LED Bulb - R16 200 - 299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - R16 300 - 599 Lumens | 300 | 599 | | 40 | |
| Energy Star LED Bulb - R16 600 - 849 Lumens | 600 | 849 | | 50 | |
| Energy Star LED Bulb - R16 850 - 999 Lumens | 850 | 999 | | 55 | |
| Energy Star LED Bulb - R16 1000 - 1300 Lumens | 1000 | 11300 | | 65 | |
| Energy Star LED Bulb - G16.5 250-349 Lumens | 250 | 349 | | 0 | |
| Energy Star LED Bulb - G16.5 350-499 Lumens | 350 | 499 | | 0 | |
| Energy Star LED Bulb - G16.5 500-574 Lumens | 500 | 574 | | 43 | |
| Energy Star LED Bulb - G16.5 575-649 Lumens | 575 | 649 | | 53 | |
| Energy Star LED Bulb - G16.5 650-1099 Lumens | 650 | 1099 | | 72 | |
| Energy Star LED Bulb - G16.5 1100-1300 Lumens | 1100 | 1300 | | 150 | |
| Energy Star LED Bulb - G25 250-349 Lumens | 250 | 349 | | 0 | |
| Energy Star LED Bulb - G25 350-499 Lumens | 350 | 499 | | 0 | |
| Energy Star LED Bulb - G25 500-574 Lumens | 500 | 574 | | 43 | |
| Energy Star LED Bulb - G25 575-649 Lumens | 575 | 649 | | 53 | |
| Energy Star LED Bulb - G25 650-1099 Lumens | 650 | 1099 | | 72 | |
| Energy Star LED Bulb - G25 1100-1300 Lumens | 1100 | 1300 | | 150 | |
| Energy Star LED Bulb - PAR16 200-299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - PAR16 300-599 Lumens | 300 | 599 | | 40 | |
| Energy Star LED Bulb - PAR16 600-849 Lumens | 600 | 849 | | 50 | |
| Energy Star LED Bulb - PAR16 850-999 Lumens | 850 | 999 | | 55 | |
| Energy Star LED Bulb - PAR16 1000-1300 Lumens | 1000 | 1300 | | 65 | |
|  | 200 | 299 | | 30 | |
| Energy Star LED Bulb - PAR20 300-599 Lumens | 300 | 599 | | 40 | |
| Energy Star LED Bulb - PAR20 600-849 Lumens | 600 | 849 | | 50 | |
| Energy Star LED Bulb - PAR20 850-999 Lumens | 850 | 999 | | 55 | |
| Energy Star LED Bulb - PAR20 1000-1300 Lumens | 1000 | 1300 | | 65 | |
| N/A | N/A | N/A | | N/A | |
| N/A | N/A | N/A | | N/A | |
| N/A | N/A | N/A | | N/A | |
| Energy Star LED Bulb - R20 200-299 Lumens | 200 | 299 | | 30 | |
| Energy Star LED Bulb - R20 300-399 Lumens | 300 | 399 | | 40 | |
| Energy Star LED Bulb - R20 400-449 Lumens | 400 | 449 | | 40 | |
| Energy Star LED Bulb - R20 450-715 Lumens | 450 | 715 | | 45 | |
| Energy Star LED Bulb - R20 716-849 Lumens | 716 | 849 | | 50 | |
| Energy Star LED Bulb - R20 850-999 Lumens | 850 | 999 | | 55 | |
| Energy Star LED Bulb - R20 1000-1300 Lumens | 1000 | 1300 | | 65 | |
| N/A |  |  | |  | |
| Energy Star LED Bulb - BR20 |  |  | |  | |
| Energy Star LED Bulb - Other |  |  | |  | |
| Energy Star LED Fixture - Bath Vanity |  |  | |  | |
| Energy Star LED Fixture - Bath Vanity <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Bath Vanity 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Bath Vanity >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Ceiling Mount |  |  | |  | |
| Energy Star LED Fixture - Ceiling Mount <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Ceiling Mount 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Ceiling Mount >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Close to Ceiling Mount |  |  | |  | |
| Energy Star LED Fixture - Close to Ceiling Mount <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Close to Ceiling Mount 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Close to Ceiling Mount >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Cove Mount |  |  | |  | |
| Energy Star LED Fixture - Cove Mount <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Cove Mount 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Cove Mount >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Decorative Pendant |  |  | |  | |
| Energy Star LED Fixture - Decorative Pendant <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Decorative Pendant 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Decorative Pendant >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Downlight Pendant |  |  | |  | |
| Energy Star LED Fixture - Downlight Pendant <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Downlight Pendant 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Downlight Pendant >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Solid State Retrofit |  |  | |  | |
| Energy Star LED Fixture - Solid State Retrofit <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Solid State Retrofit 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Solid State Retrofit >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Downlight Surface Mount |  |  | |  | |
| Energy Star LED Fixture - Downlight Surface Mount <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Downlight Surface Mount 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Downlight Surface Mount >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Outdoor Pole-Mount |  |  | |  | |
| Energy Star LED Fixture - Outdoor Pole-Mount <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Outdoor Pole-Mount 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Outdoor Pole-Mount >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Security |  |  | |  | |
| Energy Star LED Fixture - Security <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Security 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Security >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Wall Sconces |  |  | |  | |
| Energy Star LED Fixture - Wall Sconces <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Wall Sconces 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Wall Sconces >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Other |  |  | |  | |
| Energy Star LED Fixture - Other <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Other 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Other >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Outdoor (Various Types) |  |  | |  | |
| Energy Star LED Fixture - Outdoor (Various Types) <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Outdoor (Various Types) 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Outdoor (Various Types) >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Pendant |  |  | |  | |
| Energy Star LED Fixture - Pendant <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Pendant 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Pendant >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Recessed Downlight |  |  | |  | |
| Energy Star LED Fixture - Recessed Downlight <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Recessed Downlight 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Recessed Downlight >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Torchiere <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Torchiere 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Torchiere >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Wrapped Lens |  |  | |  | |
| Energy Star LED Fixture - Wrapped Lens <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Wrapped Lens 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Wrapped Lens >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Linear Strip |  |  | |  | |
| Energy Star LED Fixture - Linear Strip <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Linear Strip 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Linear Strip >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Under Cabinet |  |  | |  | |
| Energy Star LED Fixture - Under Cabinet <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Under Cabinet 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Under Cabinet >3,000 Lumens | 3000 |  | | 200 | |
| Energy Star LED Fixture - Accent Light Line Voltage |  |  | |  | |
| Energy Star LED Fixture - Accent Light Line Voltage <1,499 Lumens |  | 1499 | | 51.875 | |
| Energy Star LED Fixture - Accent Light Line Voltage 1,500 to 2,999 Lumens | 1500 | 2999 | | 136.25 | |
| Energy Star LED Fixture - Accent Light Line Voltage >3,000 Lumens | 3000 |  | | 200 | |
| LED Wall-Wash Luminaires |  |  | | 17.7 | |
| LED Track or Mono-point Directional Lighting Fixtures: 400-472 Lumens | 400 | 472 | | 10 | |
| LED Track or Mono-point Directional Lighting Fixtures: 473-524 Lumens | 473 | 524 | | 11 | |
| LED Track or Mono-point Directional Lighting Fixtures: 525-714 Lumens | 525 | 714 | | 14 | |
| LED Track or Mono-point Directional Lighting Fixtures: 715-937 Lumens | 715 | 937 | | 18 | |
| LED Track or Mono-point Directional Lighting Fixtures: 938-1259 Lumens | 938 | 1259 | | 24 | |
| LED Track or Mono-point Directional Lighting Fixtures: 1260-1399 Lumens | 1260 | 1399 | | 30 | |
| LED Track or Mono-point Directional Lighting Fixtures: 1400-1739 Lumens | 1400 | 1739 | | 35 | |
| LED Track or Mono-point Directional Lighting Fixtures: 1740-2174 Lumens | 1740 | 2174 | | 43 | |
| LED Track or Mono-point Directional Lighting Fixtures: 2175-2624 Lumens | 2175 | 2624 | | 53 | |
| LED Track or Mono-point Directional Lighting Fixtures: 2625-2999 Lumens | 2625 | 2999 | | 62 | |
| LED Track or Mono-point Directional Lighting Fixtures: 3000-3300 Lumens | 3000 | 3300 | | 70 | |
| 2 x 4 LED new luminaire 3000-4500 Lumens | 3000 | 4500 | | 59.48 | |
| 2 x 4 LED new luminaire 4501-6000 Lumens | 4501 | 6000 | | 96.24 | |
| 2 x 4 LED new luminaire 6001-7500 Lumens | 6001 | 7500 | | 128.32 | |
| 2 x 4 LED integrated retrofit kit | 3000 | 4500 | | 59.48 | |
| 2 x 4 LED integrated retrofit kit | 4501 | 6000 | | 96.24 | |
| 2 x 4 LED integrated retrofit kit | 6001 | 7500 | | 128.32 | |
| 2 x 2 LED new luminaire | 2000 | 3500 | | 59.48 | |
| 2 x 2 LED new luminaire | 3501 | 5000 | | 96.24 | |
| 2 x 2 LED integrated retrofit kit | 2000 | 3500 | | 59.48 | |
| 2 x 2 LED integrated retrofit kit | 3501 | 5000 | | 96.24 | |
| 1 x 4 LED new luminaire | 1500 | 3000 | | 30.06 | |
| 1 x 4 LED new luminaire | 3001 | 4500 | | 59.48 | |
| 1 x 4 LED new luminaire | 4501 | 6000 | | 96.24 | |
| 1 x 4 LED integrated retrofit kit | 1500 | 3000 | | 30.06 | |
| 1 x 4 LED integrated retrofit kit | 3001 | 4500 | | 59.48 | |
| 1 x 4 LED integrated retrofit kit | 4501 | 6000 | | 96.24 | |
| LED direct/indirect linear ambient 2 ft. new luminaire 1500-3500 Lumens | 1500 | 3500 | | 33 | |
| LED direct/indirect linear ambient 2 ft. new luminaire 3501-5500 Lumens | 3501 | 5500 | | 61 | |
| LED direct/indirect linear ambient 3 ft. new luminaire |  |  | | 23 | |
| LED direct/indirect linear ambient 4 ft. new luminaire <=2132 |  | 2132 | | 31 | |
| LED direct/indirect linear ambient 4 ft. new luminaire 2133-4261 Lumens | 2133 | 4261 | | 59 | |
| LED direct/indirect linear ambient 4 ft. new luminaire  4262-6392 Lumens | 4262 | 6392 | | 89 | |
| LED direct/indirect linear ambient 4 ft. new luminaire 6393-9400 Lumens | 6393 | 9400 | | 112 | |
| LED direct/indirect linear ambient 6 ft. new luminaire |  |  | |  | |
| LED direct/indirect linear ambient 8 ft. new luminaire <=3290 Lumens |  | 3290 | | 58 | |
| LED direct/indirect linear ambient 8 ft. new luminaire 3291 - 6580 Lumens | 3291 | 6580 | | 109 | |
| LED direct/indirect linear ambient 8 ft. new luminaire 6581-9870 Lumens | 6581 | 9870 | | 167 | |
| LED direct/indirect linear ambient 8 ft. new luminaire >=9871 Lumens | 9871 |  | | 219 | |
| LED direct linear ambient 2 ft retrofit kit 1500-3500 Lumens | 1500 | 3500 | | 33 | |
| LED direct linear ambient 2 ft retrofit kit 3501-5500 Lumens | 3501 | 5500 | | 61 | |
| LED direct linear ambient 4 ft retrofit kit <=2132 Lumens |  | 2132 | | 31 | |
| LED direct linear ambient 4 ft retrofit kit 2133-4261 Lumens | 2133 | 4261 | | 59 | |
| LED direct linear ambient 4 ft retrofit kit 4262-6392 Lumens | 4262 | 6392 | | 89 | |
| LED direct linear ambient 4 ft retrofit kit 6393-9400 | 6393 | 9400 | | 112 | |
| LED direct linear ambient 8 ft retrofit kit <=3290 Lumens |  | 3290 | | 58 | |
| LED direct linear ambient 8 ft retrofit kit 3291-6580 Lumens | 3291 | 6580 | | 109 | |
| LED direct linear ambient 8 ft retrofit kit 6581-9870 Lumens | 6581 | 9870 | | 167 | |
| LED direct linear ambient 8 ft retrofit kit >=9871 Lumens | 9871 |  | | 219 | |
| 1 Lamp External Driver Type C |  |  | |  | |
| 2 Lamp External Driver Type C |  |  | |  | |
| 3 Lamp External Driver Type C |  |  | |  | |
| 4 Lamp External Driver Type C |  |  | |  | |
| 6 Lamp External Driver Type C |  |  | |  | |
| Highbay Aisle Luminaire ≤125W 10001-15000 Lumens | 10001 | 15000 | | 196 | |
| Highbay Aisle Luminaire>125W & ≤250W 150001-20000 Lumens | 15001 | 20000 | | 294 | |
| Highbay Aisle Luminaire >250W >=20000 Lumens | 20000 |  | | 392 | |
| High-Bay Luminaires for Commercial and Industrial Buildings ≤125W 10001-15000 Lumens | 10001 | 15000 | | 196 | |
| High-Bay Luminaires for Commercial and Industrial Buildings >125W & ≤250W 15001-20000 Lumens | 15001 | 20000 | | 294 | |
| High-Bay Luminaires for Commercial and Industrial Buildings >250W >=20000 Lumens | 20000 |  | | 392 | |
| Low-Bay Luminaires for Commercial and Industrial Buildings ≤125W <=10000 Lumens | 10000 | | 157 | |
| Low-Bay Luminaires for Commercial and Industrial Buildings >125W & ≤250W |  |  | |  | |
| Low-Bay Luminaires for Commercial and Industrial Buildings >250W |  |  | |  | |
| Retrofit Kits for High-Bay Luminaires for Commercial and Industrial Buildings ≤125W 10001-15000 Lumens | 10001 | 15000 | | 196 | |
| Retrofit Kits for High-Bay Luminaires for Commercial and Industrial Buildings > 125 - ≤250W 15001-20000 Lumens | 15001 | 20000 | | 294 | |
| Retrofit Kits for High-Bay Luminaires for Commercial and Industrial Buildings >250W >=20000 Lumens | 20000 |  | | 392 | |
| Retrofit Kits for Low-Bay Luminaires for Commercial and Industrial Buildings ≤125W <=10000 Lumens | 10000 | | 157 | |
| High Bay LED - 5,000 to 9,999 Lumens | 5000 | 9999 | | 157 | |
| High Bay LED - 10,000 to 19,999 Lumens | 10000 | 19999 | | 262.5 | |
| High Bay LED - 20,000 to 29,999 Lumens | 20000 | 29999 | | 634 | |
| High Bay LED - 30,000 to 39,999 Lumens | 30000 | 39999 | | 767.5 | |
| High Bay LED - ≥40,000 Lumens | 40000 |  | | 901 | |
| Low Bay LED - 5,000 to 9,999 Lumens | 5000 | 9999 | | 151.5 | |
| Low Bay LED - 10,000 to 19,999 Lumens | 10000 | 19999 | | 272.5 | |
| Low Bay LED - 20,000 to 29,999 Lumens | 20000 | 29999 | | 634 | |
| Low Bay LED - 30,000 to 39,999 Lumens | 30000 | 39999 | | 767.5 | |
| Low Bay LED - ≥40,000 Lumens | 40000 |  | | 901 | |
| HID Replacement Lamp ≤125W |  |  | | 171 | |
| HID Replacement Lamp>125W - ≤250W |  |  | | 288 | |
| HID Replacement Lamp >250W |  |  | | 452 | |
| 2' Replacement Lamp |  |  | | 16.5 | |
| 3' Replacement Lamp |  |  | | 26 | |
| 4' Replacemnet Lamp |  | 3200 | | 29.5 | |
| 4' High Output Replacement Lamp | 3200 |  | | 54 | |
| 8' Replacement Lamp |  | 4000 | | 59 | |
| 8' Replacement Lamp | 4001 |  | | 86 | |
| U -Bend Lamp | 1500 | 2000 | | 29.5 | |
| U -Bend Lamp | 2001 | 3276 | | 54 | |
| Horizontally-Mounted Lamps 760-934 Lumens | 760 | 934 | | 13 | |
| Horizontally-Mounted Lamps 935-1349 Lumens | 935 | 1349 | | 18 | |
| Horizontally-Mounted Lamps 1350-1834 Lumens | 1350 | 1834 | | 26 | |
| Horizontally-Mounted Lamps 1835-2549 Lumens | 1835 | 2549 | | 32 | |
| Horizontally-Mounted Lamps 2550-3199 Lumens | 2550 | 3199 | | 42 | |
| Vertically-Mounted Lamps 760-934 Lumens | 760 | 934 | | 13 | |
| Vertically-Mounted Lamps 935-1349 Lumens | 935 | 1349 | | 18 | |
| Vertically-Mounted Lamps 1350-1834 Lumens | 1350 | 1834 | | 26 | |
| Vertically-Mounted Lamps 1835-2549 Lumens | 1835 | 2549 | | 32 | |
| Vertically-Mounted Lamps 2550-3199 Lumens | 2550 | 3199 | | 42 | |
| 2G11 Base Lamps 760-934 Lumens | 760 | 934 | | 13 | |
| 2G11 Base Lamps 935-1349 Lumens | 935 | 1349 | | 18 | |
| 2G11 Base Lamps 1350-1834 Lumens | 1350 | 1834 | | 26 | |
| 2G11 Base Lamps 1835-2549 Lumens | 1835 | 2549 | | 32 | |
| 2G11 Base Lamps 2550-3199 Lumens | 2550 | 3199 | | 42 | |
| Display Case Luminaire |  |  | | 7.1 per ft | |
| Refrigerated Case Lighting 4' |  |  | | 60.8 | |
| Refrigerated Case Lighting 5' |  |  | | 76 | |
| Refrigerated Case Lighting 6' |  |  | | 91.2 | |
| LED Architectural Flood and Spot Luminaries |  |  | |  | |
| LED Architectural Flood and Spot Luminaries - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Architectural Flood and Spot Luminaries - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Architectural Flood and Spot Luminaries - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Architectural Flood and Spot Luminaries - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Architectural Flood and Spot Luminaries - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Architectural Flood and Spot Luminaries - ≥40,000 Lumens | 40000 |  | | 1090 | |
| LED Bollard Fixtures |  |  | |  | |
| LED Bollard Fixtures - Up to 4,999 Lumens |  | 4999 | | 113.6 | |
| LED Bollard Fixtures - 5,000 to 9,999 Lumens | 5000 | 9999 | | 198.9 | |
| LED Bollard Fixtures - 10,000 to 19,999 Lumens | 10000 | 19999 | | 284.1 | |
| LED Bollard Fixtures - 20,000 to 29,999 Lumens | 20000 | 29999 | |  | |
| LED Bollard Fixtures - 30,000 to 39,999 Lumens | 30000 | 39999 | |  | |
| LED Bollard Fixtures - ≥40,000 Lumens | 40000 |  | |  | |
| LED Fuel Pump Canopy |  |  | |  | |
| LED Fuel Pump Canopy - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Fuel Pump Canopy - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Fuel Pump Canopy - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Fuel Pump Canopy - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Fuel Pump Canopy - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Fuel Pump Canopy - ≥40,000 Lumens | 40000 |  | | 1090 | |
| LED Landscape/Accent Flood and Spot Luminaires |  |  | |  | |
| LED Landscape/Accent Flood and Spot Luminaires - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Landscape/Accent Flood and Spot Luminaires - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Landscape/Accent Flood and Spot Luminaires - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Landscape/Accent Flood and Spot Luminaires - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Landscape/Accent Flood and Spot Luminaires - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Landscape/Accent Flood and Spot Luminaires - ≥40,000 Lumens | 40000 |  | | 1090 | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires |  |  | |  | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Outdoor Pole/Arm-Mounted Area and Roadway Luminaires - ≥40,000 Lumens | 40000 |  | | 1090 | |
| LED Large Outdoor Pole/Arm-Mounted Area and Roadway Retrofit |  |  | |  | |
| LED Outdoor Pole/Arm-Mounted Decorative Luminaires |  |  | |  | |
| LED Outdoor Wall-Mounted Area Luminaires |  |  | |  | |
| LED Outdoor Wall-Mounted Area Luminaires - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Outdoor Wall-Mounted Area Luminaires - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Outdoor Wall-Mounted Area Luminaires - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Outdoor Wall-Mounted Area Luminaires - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Outdoor Wall-Mounted Area Luminaires - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Outdoor Wall-Mounted Area Luminaires - ≥40,000 Lumens | 40000 |  | | 1090 | |
| LED Parking Garage Luminaires |  |  | |  | |
| LED Parking Garage Luminaires - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Parking Garage Luminaires - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Parking Garage Luminaires - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Parking Garage Luminaires - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Parking Garage Luminaires - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Parking Garage Luminaires - ≥40,000 Lumens | 40000 |  | | 1090 | |
| LED Stairwell and Passageway Luminaires |  |  | |  | |
| LED Stairwell and Passageway Luminaires - Up to 4,999 Lumens |  | 4999 | | 133 | |
| LED Stairwell and Passageway Luminaires - 5,000 to 9,999 Lumens | 5000 | 9999 | | 215 | |
| LED Stairwell and Passageway Luminaires - 10,000 to 19,999 Lumens | 10000 | 19999 | | 295 | |
| LED Stairwell and Passageway Luminaires - 20,000 to 29,999 Lumens | 20000 | 29999 | | 462 | |
| LED Stairwell and Passageway Luminaires - 30,000 to 39,999 Lumens | 30000 | 39999 | | 843 | |
| LED Stairwell and Passageway Luminaires - ≥40,000 Lumens | 40000 |  | | 1090 | |

## 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| **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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |

# Appendix M: Non-energy Benefits

This section provides non-energy benefit multipliers for low-income and non low-income programs for use in calculating program cost effectivess.[[213]](#footnote-215)

**Non-energy benefits (NEB) for non low-income programs**

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.

**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.

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. [↑](#footnote-ref-2)
2. See PJM Manual 18B, section 10.2. [↑](#footnote-ref-3)
3. Assumes average of 56 minutes per cycle based on Ecova, ‘Dryer Field Study’, Northwest Energy Efficiency Alliance (NEEA) 2014. [↑](#footnote-ref-4)
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. [↑](#footnote-ref-5)
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. [↑](#footnote-ref-6)
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. [↑](#footnote-ref-7)
7. 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> [↑](#footnote-ref-8)
8. 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> [↑](#footnote-ref-9)
9. Values from the JCPL PY2 Evaluation of the Refrigeator and Freezer Recycling Program applied to the UMP refrigerator and freezer UEC regression models. [↑](#footnote-ref-10)
10. 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. [↑](#footnote-ref-11)
11. CEE Tier 1 is aligned with the ENERGY STAR Version 5.1 specifcation for resendential refrigerators. [↑](#footnote-ref-12)
12. 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. [↑](#footnote-ref-13)
13. 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. [↑](#footnote-ref-14)
14. Assumes equal likelihood of usage at any time of day (16/24 hours) [↑](#footnote-ref-15)
15. 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 [60] [↑](#footnote-ref-16)
16. Secondary refrigerators are spare or backup refrigerators not installed in the kitchen. [↑](#footnote-ref-17)
17. Annual savings for compact refrigerators based on average annual consumption of compact refrigerators compliant with US Federal Standards. Data available here: <https://www.energystar.gov/productfinder/download/certified-residential-refrigerators/> [↑](#footnote-ref-18)
18. Values from the JCPL PY2 Evaluation of the Refrigeator and Freezer Recyling Program applied to the UMP refrigerator and freezer UEC regression models. [↑](#footnote-ref-19)
19. Default manufacture date assumes that 2/3 of dehumidifier EUL (12 years) have elapsed [73]   
    (2/3) x (12 years) = 8 year vintage  
    2023 – (8 years) = 2015 manufacture date [↑](#footnote-ref-20)
20. Default run hour assumption based on 68 days per year, 24 hours of use [74]. [↑](#footnote-ref-21)
21. For ductless heat pumps, Fload is calculated as the actual heating output of the heat pump divided by the total theoretical heating output. Total theoretical heating output is represented by the heat pump rated heating capacity multiplied by annual full load heating hours. See Table 2‑64 for more information.  
    For ducted heat pumps, where the system is more likely to function with a temperature-based switchover from one central system to another, Fload is represented by the fraction of annual heating degree hours that are above the switchover temperature. See Table 2‑65 for more information. [↑](#footnote-ref-22)
22. Weights calculated by quantity of heat pump projects designated as fuel switching by measure name in the Tri 2 utility filings workbooks. [↑](#footnote-ref-23)
23. The baseline heating factors presented in Table 2‑63 are based on reference [93]. Fbaseline,h is calculated as the total percent of respondents who would install new baseline equipment, averaged across heating fuel types in table 2-17 of the report. [↑](#footnote-ref-24)
24. The baseline cooling factors presented in Table 2‑63 are based on reference [93]. Fbaseline,c is calculated as the percent of respondents without existing cooling who would not have installed an alternative cooling system without the heat pump. The percent of respondents who installed a central heat pump with no existing cooling was assumed to be 46%, based on the known proportion of respondents who installed a minisplit with no existing cooling. [↑](#footnote-ref-25)
25. 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 [↑](#footnote-ref-26)
26. 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. [↑](#footnote-ref-27)
27. Partial displacement factors represent the fraction of the heating load provided by the heat pump. For ductless heat pumps, the partial displacement factors are calculated using data from a 2022 Heat Pump Impact Evaluation, prepared for NYSERDA by DNV (<https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/PPSER/Program-Evaluation/Heat-Pump-Impact-Evaluation-Report-August-2022.pdf>). The load fractions for ductless heat pumps are calculated as the measured annual heat output of the ductless heat pump divided by the total predicted annual heat output using rated heating capacity:

    𝐹𝑙𝑜𝑎𝑑=((𝐴𝑐𝑡𝑢𝑎𝑙 ℎ𝑒𝑎𝑡 𝑜𝑢𝑡𝑝𝑢𝑡 𝑝𝑒𝑟 𝑚𝑒𝑡𝑒𝑟𝑒𝑑 𝑑𝑎𝑡𝑎, 𝐵𝑡𝑢/𝑦𝑟))/((𝑇𝑜𝑡𝑎𝑙 *heat pump* 𝑐𝑎𝑝𝑎𝑐𝑖𝑡𝑦,𝐵𝑡𝑢∕ℎ)×𝐸𝐹𝐿𝐻𝐻𝑒𝑎𝑡𝑖𝑛𝑔)

    The New York load fractions for ductless heat pumps were mapped to New Jersey climate zones based on the corresponding ASHRAE climate zone. Default to statewide average if site-specific climate zone is unknown. [↑](#footnote-ref-28)
28. Partial displacement factors represent the fraction of the heating load provided by the heat pump. For ducted heat pumps, the partial displacement factors are based on the percentage of heating degree hours above the “switchover point,” or the point at which heating is assumed to switch from the heat pump to the supplemental system. Assume a default switchover point of 35°F unless a site-specific switchover point is known and supported with documentation such as a photo of programmed controls. [↑](#footnote-ref-29)
29. SEER to SEER2 conversion found in Appendix E. [↑](#footnote-ref-30)
30. This parameter represents the additional energy consumption unrelated to cooling or heating. For ground source heat pumps, it represents the pump energy to circulate the heat exchange fluid through the ground loop. For furnaces, it represents the fan energy to distribute the heated air. [↑](#footnote-ref-31)
31. This equation was derived by constructing a simple linear regression model that relates the output furnace heating capacity to the fan auxiliary usage using data downloaded from the AHRI website for all active residential furnaces. [↑](#footnote-ref-32)
32. 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 [↑](#footnote-ref-33)
33. Weighted average calculated using RECS 2020 Data -https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%207.7.pdf [↑](#footnote-ref-35)
34. Cooling assumes three months (92 days) of 24 hour operation [↑](#footnote-ref-36)
35. If needed, calculate EER as follows: [↑](#footnote-ref-37)
36. If needed, convert COP to HSPF as follows:

    . COP for electric resistance heat is 1.0 [↑](#footnote-ref-38)
37. 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. [↑](#footnote-ref-39)
38. Assuming 50% relative humidity [↑](#footnote-ref-40)
39. VEIC estimate. Extrapolation of manufacturer data. [↑](#footnote-ref-41)
40. VEIC Estimate. Consistent with analysis of PEPCo and LIPA, and conservative relative to ARI. [↑](#footnote-ref-42)
41. Typical blower motor capacity for gas furnace is ¼ to ¾ HP, Avg of ½ HP =0.377kW. [↑](#footnote-ref-43)
42. ENERGY STAR® V2.0 Connected Thermostats is under development. [↑](#footnote-ref-44)
43. Assumes a 1,800 ft2 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 [↑](#footnote-ref-45)
44. Assumes a 1,800 ft2 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 [↑](#footnote-ref-46)
45. Assumes a 1,800 ft2 home with 40 Btu/h-ft2 heating load and 80% AFUE: 1,800 ft2 x 40 Btu/h-ft2 x 1/0.80 x 1/(1,000 kBtu/h)/(Btu/h) = 90 kBtu/h [↑](#footnote-ref-47)
46. The coincidence value is an estimate based on the on-mode hours per day (5 hours/day) as a percentage of all hours. [↑](#footnote-ref-48)
47. kW for non-networked and networked type = (((Wb – Wq,p)\*HrsPS/8482) + ((Wb – Wq,u)\*HrsUS/8482))/1000 [↑](#footnote-ref-49)
48. Annual hours of use divided by Working Time Per Charge [↑](#footnote-ref-50)
49. Battery Charging Time to 100% divided by 60 minutes [↑](#footnote-ref-51)
50. 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 ∆CFM50/SF of 0.50 (i.e., ∆CFM50 = 0.50 x SF). Default ∆CFM50/SF of 0.50 is the median value of single-family blower door test data provided by ConEdison, conducted 2018-2020. [↑](#footnote-ref-52)
51. Average Window Size - homedit.com [↑](#footnote-ref-53)
52. Based on RECS microdata weights for prevalence of heat pumps and electric resistance heating and 2013 heat pump efficiencies [↑](#footnote-ref-54)
53. Average of gas-fired hot water boiler, steam boiler, and furnace 2013 minimum efficiencies [↑](#footnote-ref-55)
54. Inspectapedia air gap R value of 0.87 per inch, assuming 2 inches air gap between interior glazing surface and front of interior window frame trim. [↑](#footnote-ref-56)
55. 1 year is assumed to be the EUL since plastic window insulation comes in the form of single-use kits that are disposed of when the heating season ends. [↑](#footnote-ref-57)
56. Note that heat pump water heaters are code required for tanks greater than 55 gallons. [↑](#footnote-ref-58)
57. 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>).” [↑](#footnote-ref-59)
58. Unknown derating and location factors based on ResStock data [↑](#footnote-ref-60)
59. ASHRAE 90.1 2019 Compliant AFUE values range from 82% to 84%. Assumed conservative estimate of 85% [↑](#footnote-ref-61)
60. 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 [↑](#footnote-ref-62)
61. Average value across NJ climate zones, calculated as average ambient air temperature + 6 °F. [↑](#footnote-ref-63)
62. Minimum UEF for instantaneous (tankless) water heaters from Energy Star [↑](#footnote-ref-64)
63. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6 deg F. [↑](#footnote-ref-65)
64. Available at: <https://www.eia.gov/consumption/residential/data/2009/hc/hc8.8.xls> [↑](#footnote-ref-66)
65. Assumes R-12 water tank [↑](#footnote-ref-67)
66. 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. [↑](#footnote-ref-68)
67. 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. [↑](#footnote-ref-69)
68. 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. [↑](#footnote-ref-70)
69. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F. See Reference [285]. [↑](#footnote-ref-71)
70. QHEC = Quick Home Energy Check-up; HPwES = Home Performance with ENERGY STAR Program [↑](#footnote-ref-72)
71. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F. [↑](#footnote-ref-73)
72. Peak electric demand embedded in ETDF. [↑](#footnote-ref-74)
73. Average of lowest typical hot water boiler setting of (120°F) and highest typical setting of (200°F). [↑](#footnote-ref-75)
74. Residential boiler’s steam temperature shall be the boiling point of water at sea level (212°F). [↑](#footnote-ref-76)
75. 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. [306] [↑](#footnote-ref-77)
76. 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. [306] [↑](#footnote-ref-78)
77. Also called Building Load Coefficient per unit length. [↑](#footnote-ref-79)
78. “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. [↑](#footnote-ref-80)
79. “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. [↑](#footnote-ref-81)
80. 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 [307]. [↑](#footnote-ref-82)
81. SnuggPro uses the OptiMiser energy modeling engine [↑](#footnote-ref-83)
82. See the California Evaluation Framework [351] Chapters 6 and 7 for more information about engineering methods. [↑](#footnote-ref-84)
83. Annual energy savings per cow was calculated based on the following assumptions.

    * An average herd size of 102 cows [359]
    * Typical dairy vacuum pump size of 10 HP per herd size [360]
    * Average pump operating hours are estimated at 10 hours per day [358]
    * A 12.5% Energy savings factor [359]

    [↑](#footnote-ref-85)
84. BESS Laboratories is a research, product testing, and educational laboratory at the University of Illinois. [↑](#footnote-ref-86)
85. look up from BESS Labs database based on manufacturer and model number. [↑](#footnote-ref-87)
86. look up from BESS Labs database based on manufacturer and model number. [↑](#footnote-ref-88)
87. 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. [↑](#footnote-ref-89)
88. 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 [↑](#footnote-ref-90)
89. Default hours are developed from NOAA hourly normals by summing annual hours dry bulb temperature above 50⁰F; NOAA National Centers for Environmental information – NCEI 2010 Hourly Normals [↑](#footnote-ref-91)
90. Exhaust/Ventilation fans are assumed to operate 75% of total annual hours (8,760 x 0.75 = 6,570) [↑](#footnote-ref-92)
91. Assumes the higher range of possible electric lawn blower electric demand. [↑](#footnote-ref-93)
92. [↑](#footnote-ref-94)
93. Annual hours of use divided by Working Time Per Charge. [↑](#footnote-ref-95)
94. Battery Charging Time to 100% divided by 60 minutes. [↑](#footnote-ref-96)
95. %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. [↑](#footnote-ref-97)
96. %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. [↑](#footnote-ref-98)
97. Assumes average of 56 minutes per cycle based on Ecova, ‘Dryer Field Study’, Northwest Energy Efficiency Alliance (NEEA) 2014. [↑](#footnote-ref-99)
98. 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. [↑](#footnote-ref-100)
99. 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. [↑](#footnote-ref-101)
100. 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. [↑](#footnote-ref-102)
101. 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. [↑](#footnote-ref-103)
102. <https://legiscan.com/NJ/bill/A5160/2020>. [↑](#footnote-ref-104)
103. Assumes 6 pans [↑](#footnote-ref-105)
104. Assumes 6 pans [↑](#footnote-ref-106)
105. Assumes 3-foot griddle width, 2-foot griddle depth [↑](#footnote-ref-107)
106. Assumes 3-foot griddle width, 2-foot griddle depth [↑](#footnote-ref-108)
107. Shared assumption from all PG&E Work Papers referenced in this measure [↑](#footnote-ref-109)
108. SEER to SEER2 conversion found in Appendix E. [↑](#footnote-ref-110)
109. Fload is represented by the fraction of annual heating degree hours that are above the switchover temperature. See Table 2‑64 for more information. [↑](#footnote-ref-111)
110. Weights calculated by quantity of heat pump projects designated as fuel switching by measure name in the Tri 2 utility filings workbooks. [↑](#footnote-ref-112)
111. The baseline heating factors presented in Table 2‑63 are based on reference [521]. Fbaseline,h is calculated as the total percent of respondents who would install new baseline equipment, averaged across heating fuel types in table 2-17 of the report. [↑](#footnote-ref-113)
112. The baseline cooling factors presented in Table 2‑63 are based on reference [521]**Error! Reference source not found.**. Fbaseline,c is calculated as the percent of respondents without existing cooling who would not have installed an alternative cooling system without the heat pump. The percent of respondents who installed a central heat pump with no existing cooling was assumed to be 46%, based on the known proportion of respondents who installed a minisplit with no existing cooling. [↑](#footnote-ref-114)
113. 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 [↑](#footnote-ref-115)
114. 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. [↑](#footnote-ref-116)
115. Partial displacement factor represents the fraction of the heating load provided by the heat pump. It is based on the percentage of heating degree hours above the “switchover point,” or the point at which heating is assumed to switch from the heat pump to the supplemental system. Assume a default switchover point of 35°F unless a site-specific switchover point is known and supported with documentation such as a photo of programmed controls. [↑](#footnote-ref-117)
116. This parameter represents the additional energy consumption aside from direct cooling or heating. For ground source heat pumps, it represents the pump energy to circulate the heat exchange fluid through the ground loop. For furnaces, it represents the fan energy to distribute the heated air. [↑](#footnote-ref-118)
117. This equation was derived by constructing a simple linear regression model that relates the output furnace heating capacity to the fan auxiliary usage using data downloaded from the AHRI website for all active residential-sized furnaces. [↑](#footnote-ref-119)
118. 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 [↑](#footnote-ref-120)
119. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F [↑](#footnote-ref-121)
120. Assumes hot water boiler efficiency of 82% and steam boiler efficiency of 80% [↑](#footnote-ref-122)
121. 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 [↑](#footnote-ref-123)
122. Ibid, the minimum stack temperature for a non-condensing economizer is 250°F: (500°F + 250°F ) / 2 = 375°F [↑](#footnote-ref-124)
123. Ibid, the minimum stack temperature for a condensing economizer is 75°F: (420°F + 75°F ) / 2 = 247.5°F [↑](#footnote-ref-125)
124. Ibid, the minimum stack temperature for a condensing economizer is 75°F: (500°F + 75°F ) / 2 = 287.5°F [↑](#footnote-ref-126)
125. 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. [↑](#footnote-ref-127)
126. 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. [↑](#footnote-ref-128)
127. If needed, calculate EER as follows: [↑](#footnote-ref-129)
128. If needed, convert COP to HSPF as follows: [↑](#footnote-ref-130)
129. Based on ¼ hp, 4-pole polyphase motor. 10 CFR 431.446 [↑](#footnote-ref-131)
130. 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. [↑](#footnote-ref-132)
131. [↑](#footnote-ref-133)
132. 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) [↑](#footnote-ref-134)
133. 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. [↑](#footnote-ref-135)
134. 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> [↑](#footnote-ref-136)
135. Weighted average based on NJ climate zone distribution. [↑](#footnote-ref-137)
136. Annual heating hours calculated as the total number of hours colder than 65°F for each climate zone, using representative climate stations and TMY3 weather data. [↑](#footnote-ref-138)
137. Default value assumes operating hours is 12 hours a day, 7 days a week. [↑](#footnote-ref-139)
138. 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. [↑](#footnote-ref-140)
139. For heat pumps: HSPF = COP x 3.413, where COP is coefficient of performance [↑](#footnote-ref-141)
140. 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. [↑](#footnote-ref-142)
141. 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) [↑](#footnote-ref-143)
142. 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. [↑](#footnote-ref-144)
143. ASHRAE 90.1 2019, https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards [↑](#footnote-ref-145)
144. ECCCNYS 2020 C406.9 Reduced air infiltration. [↑](#footnote-ref-146)
145. U.S. Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes, Version 3, May 11, 2012, p. 7 [↑](#footnote-ref-147)
146. NIST, Analysis of U.S. Commercial Building Envelope Air Leakage Database to Support Sustainable Building Design. Analysis of air sealing in commercial buildings demonstrates buildings exceeding ECCCNYS Additional Efficiency Packages requirements. [↑](#footnote-ref-148)
147. LBL, Exegesis of Proposed ASHRAE Standard 119: Air Leakage Performance For Detached Single-Family Residential Buildings, M.Sherman, July 1986, pg. 12. [↑](#footnote-ref-149)
148. The multiplier accommodates for the energy savings impacts associated with decreased humidity influx in a building with improved air sealing. During the cooling season, humidity poses an additional load on the cooling system. The Latent Multiplier is the ratio of total heat load (latent and sensible) to sensible heat load. Set indoor conditions are taken as 75ºF and 50% rh. [↑](#footnote-ref-150)
149. If needed, convert COP to HSPF as follows: HSPF = COP × 3.412 [↑](#footnote-ref-151)
150. ASHRAE Journal, Dehumidification and Cooling Loads From Ventilation Air, Lewis Harriman, November 1997. [↑](#footnote-ref-152)
151. Estimated 16.8 square feet of gap area. The leakage area is comprised of gaps on top, bottom and on the sides of the dock door. Common dock door dimensions are 8’0” in width with 8 ft, 9 ft or 10 ft heights. The maximum trailer size limits are 8’6” wide x 13’6” high (varies by state). Most trucks require a dock height of between 46 and 52 in. For the purposes of this calculation a 48” dock height and 9’0” wide x 10’0” high door was use, to cover the full range of truck types. [↑](#footnote-ref-153)
152. For equipment rated in EER2, use EER2. If unknown, calculate EER as follows: [↑](#footnote-ref-154)
153. If needed, convert COP to HSPF as follows: [↑](#footnote-ref-155)
154. Assumes 23-hour per day operation 5 days per week, with an average loading time of 45 minutes (including truck arrival and departure time). Average time between trucks estimated at 90 minutes taken from customer interviews. 5 day/7 days \* 23 hr/day / 90 minutes per truck event x 45 minutes door open time per truck event = 8.39 average hr/day, 7 days/week. [↑](#footnote-ref-156)
155. Average wind speeds are calculated based on the TMY3 wind speed data [↑](#footnote-ref-157)
156. Because wind direction is not constant, a wind speed correction factor is used to adjust for the amount of time during the cooling season that prevailing winds can be expected to impact the entryway. [↑](#footnote-ref-158)
157. ASHRAE, “Ventilation and Infiltration,” in 2013 ASHRAE Handbook – Fundamentals (2013): p 16.13 [↑](#footnote-ref-159)
158. ASHRAE, “Ventilation and Infiltration,” in 2013 ASHRAE Handbook – Fundamentals (2013): p 16.13 [↑](#footnote-ref-160)
159. A single entrance is assumed for simplicity. Effects of indoor and outdoor temperature differential are expected to have negligible impact on this factor and are therefore ignored. [↑](#footnote-ref-161)
160. Calculation requires absolute temperature for values not calculated as a difference of temperatures [↑](#footnote-ref-162)
161. 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) [↑](#footnote-ref-163)
162. 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. [↑](#footnote-ref-164)
163. 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> [↑](#footnote-ref-165)
164. Calculated from TMY3 data for representative weather stations for each NJ climate zone. Cooling days are defined as any day when outdoor air temperature is above 65°F for the months of June through August and heating day are defined as any day when outdoor air temperature is below 65°F for the months of October through April. The heating and cooling days above represent the count of each in a typical meteorological year. Note: these values may over-estimate days for buildings with limited operating hours such as offices, schools, etc. Site-specific estimate should be used when possible.  [↑](#footnote-ref-166)
165. Assumes hospital operations are year round. [↑](#footnote-ref-167)
166. NEEP Mid-Atlantic TRM V9, p. 24. [↑](#footnote-ref-168)
167. From NY TRM V10, Pg 862 [↑](#footnote-ref-169)
168. 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. [↑](#footnote-ref-170)
169. 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 [↑](#footnote-ref-171)
170. 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 [↑](#footnote-ref-172)
171. Savings factors are taken from Switched-Reluctance Motor Field Evaluation Final Report (pg. 26) and Performance Evaluation of Three RTU Energy Efficiency Technologies (pg. 24), averaged across building types. Building type average was weighted according to ComStock 2018 commercial building metadata. [↑](#footnote-ref-173)
172. 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 [717]. [↑](#footnote-ref-174)
173. 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. [↑](#footnote-ref-175)
174. Ec, Et or AFUE shall be used, based on nameplate rating metric of existing equipment [↑](#footnote-ref-176)
175. 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. [↑](#footnote-ref-177)
176. Grocery Store default assumes a 25-ton packaged RTU (cooling only); Other default assumes a 10-ton packaged RTU (cooling only) [↑](#footnote-ref-178)
177. No source specified – update pending availability and review of applicable references. [↑](#footnote-ref-179)
178. 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. [↑](#footnote-ref-180)
179. 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 [13]. [↑](#footnote-ref-181)
180. Coincidence factors developed by dividing the PJM Summer Peak kW Savings for ASDH Controls from Table 52 of the reference [13] (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) [↑](#footnote-ref-182)
181. 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. [↑](#footnote-ref-183)
182. Load Factor is the ratio between the actual load and rated load. This can be estimated by spot metering and nameplate reading. [↑](#footnote-ref-184)
183. 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 [13]) by annual energy savings (kWh/HP) for the “Equipment Only” equipment type (also shown in Table 43). [↑](#footnote-ref-185)
184. 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 [13]) by the average annual energy savings (kWh/HP) for evaporator fan controls (shown in Table 43 of the report reference [13]). [↑](#footnote-ref-186)
185. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6 °F. [↑](#footnote-ref-187)
186. 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. [↑](#footnote-ref-188)
187. 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. [↑](#footnote-ref-189)
188. 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. [↑](#footnote-ref-190)
189. 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. [↑](#footnote-ref-191)
190. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F. [↑](#footnote-ref-192)
191. Based on PSEG implementor review of NREL NJ commercial building stock data [↑](#footnote-ref-193)
192. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6 deg F. [↑](#footnote-ref-194)
193. 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. [↑](#footnote-ref-195)
194. 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. [↑](#footnote-ref-196)
195. 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. [↑](#footnote-ref-197)
196. Unknown electric and fuel water heat factors from PSE&G PY3 Evaluation report [↑](#footnote-ref-198)
197. Average value across 5 NJ climate zones. Calculated from annual average ambient air temperature + 6°F. [↑](#footnote-ref-199)
198. 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. [↑](#footnote-ref-200)
199. The 80% default assumption comes from most ASHRAE 90.1 2019 minimum thermal efficiencies listed for water heater. [↑](#footnote-ref-201)
200. 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. [↑](#footnote-ref-202)
201. Also called Building Load Coefficienct per unit length [↑](#footnote-ref-203)
202. 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 [129] [↑](#footnote-ref-204)
203. Average of 2014 and 2015 values of the Low Pressure Steam related pipe temperature values in the ‘NONRESIDENTIAL DOWNSTREAM ESPI DEEMED PIPE INSULATION IMPACT EVALUATION’ studies by Ltron Inc and ERS [130]. [↑](#footnote-ref-205)
204. 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. [↑](#footnote-ref-206)
205. See the California Evaluation Framework Chapters 6 and 7 for more information about engineering methods. [↑](#footnote-ref-207)
206. https://climate.rutgers.edu/stateclim/ [↑](#footnote-ref-208)
207. https://www.nrel.gov/docs/fy08osti/43156.pdf [↑](#footnote-ref-209)
208. https://www.census.gov/library/stories/state-by-state/new-jersey-population-change-between-census-decade.html [↑](#footnote-ref-210)
209. 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](http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf). [↑](#footnote-ref-211)
210. 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 [↑](#footnote-ref-212)
211. DOE-2.2R is a specialized version of the DOE-2.2 program, designed specifically to model refrigeration systems. [↑](#footnote-ref-213)
212. Reference London Economics study [↑](#footnote-ref-214)
213. Non-Energy Benefits (NEBs) multipliers are taken from the New Jersey Cost Test (NJCT) attachment to the May 23, 2024 Board Order. See nj.gov › boardorders › 8B ORDER Energy Efficiency Triennium 2 [↑](#footnote-ref-215)