Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
9-24-1	A	10/22/2024	1/1/2025	R/MF Door and Window Seal Caulking	New measure to capture savings from silicone tube caulking around doors and windows.	Pg. x
9-24-2	R	10/22/2024	1/1/2025	R/MF Duct Sealing and Insulation	Formatting and language updates, no major changes.	Pg. 220
9-24-3	R	10/22/2024	1/1/2025	R/MF Interior and Exterior Lighting	Removed reference to existing conditions, added a 45 lumen/watt baseline for some scenarios, updated compliance language, and added a compliance table for non-DLC lights.	Pg. 361
9-24-4	R	10/22/2024	1/1/2025	R/MF Outdoor Temperature Setback Control for Hydronic Boiler	Formatting and language updates, no major changes.	Pg. 323
9-24-5	R	10/22/2024	1/1/2025	R/MF Refrigerant Charge Correction & Tune Up – Air Conditioner and Heat Pump	Added language to provide more accurate savings over the lifetime of the measure, and formatting updates.	Pg. 300
9-24-6	A	10/22/2024	1/1/2025	R/MF Shade Trees	New measure to capture savings from planting trees near single-family homes.	Pg. x
9-24-7	R	10/22/2024	1/1/2025	R/MF Tune-Up – Boiler	Added language to provide more accurate savings over the lifetime of the measure, and formatting and language updates.	Pg. 307
9-24-8	R	10/22/2024	1/1/2025	C/I High-Speed Fan	Updates to baseline and compliance values, formatting, language, and references.	Pg. 404
9-24-9	R	10/22/2024	1/1/2025	C/I Ice Maker	Formatting and language updates, no major changes.	Pg. 489
9-24-10	R	10/22/2024	1/1/2025	C/I Interior and Exterior Lighting	Updated compliance language and added a compliance table for non-DLC lights.	Pg. 896

Note: Revisions, Additions, Corrections and Removals to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between July 9, 2024 – October 22, 2024

BUILDING SHELL

DOOR AND WINDOW SEAL CAULKING

Measure Description

This measure covers the installation of door and window silicone tube caulk that seals gaps in the building envelope, preventing outside air infiltration into the dwelling. This caulk must be labelled as "exterior" or "window and door". Silicone caulk labeled for other purposes is not included to ensure incentivized products are utilized in weatherization applications. The reduced air infiltration saves energy by decreasing heating and cooling loads on the dwelling's HVAC systems.

This measure is intended to address customer DIY installation as well as installation by trained volunteers in retrofit scenarios. This measure assumes that any existing caulk is removed, and installation follows manufacturer recommended application practices. Caulking measures applied by paid weatherization professionals should utilize the broader Residential Air Leakage Sealing measure in the current version of the New York Technical Resource Manual to holistically account for savings through methods such as blower door testing. Caulking product purchased with a contractor discount or bulk pricing are ineligible under this measure.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = \frac{1.08 \times \frac{\Delta CFM}{ft} \times ft \times CDD \times 24}{SEER \times 1{,}000} \times F_{ElecCool} \times F_{Utlization}$$

$$\Delta kWh_{heating} = \frac{1.08 \times \frac{\Delta CFM}{ft} \times ft \times HDD \times 24}{COP \times 3{,}412} \times F_{ElecHeat} \times F_{Utlization}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{\Delta kWh_{cooling}}{EFLH_{cooling}} \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = \frac{1.08 \times \frac{\Delta CFM}{ft} \times ft \times HDD \times 24}{Eff_{FuelHeat} \times 1{,}000{,}000} \times F_{FuelHeat} \times F_{Utlization}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
$\Delta MMBtu$	= Annual fossil fuel energy savings
$\Delta kWh_{cooling}$	= Annual electric cooling energy savings
$\Delta kWh_{heating}$	= Annual electric heating energy savings
$\Delta CFM/ft$	= Reduction in cubic feet per minute (CFM) of air per linear foot (ft) of installed weatherization measure
ft	= Length of installed weatherization measure, in linear feet (ft)
CDD	= Cooling Degree Days - The number of degrees that a day's average temperature is above some baseline temperature, which represents the temperature above which buildings need to be cooled. The baseline temperature is typically 65°F but may vary based on application.
HDD	= Heating Degree Days - The number of degrees that a day's average temperature is below some baseline temperature, which represents the temperature below which buildings need to be heated. The baseline temperature is typically 65°F but may vary based on application.
SEER	= Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, used for average U.S. location/region
COP	= Coefficient of performance, ratio of output energy/input energy (at AHRI standard high-temperature rating conditions)
$Eff_{FuelHeat}$	= Efficiency of fuel heating equipment (AFUE, Et, or Ec)
$F_{ElecCool}$	= Electric cooling factor; used to account for the presence or absence of an electric cooling system
$F_{ElecHeat}$	= Electric heating factor; used to account for the presence or absence of an electric heating system
$F_{FuelHeat}$	= Fossil fuel heating factor; used to account for the presence or absence of a fossil fuel heating system
$F_{Utilization}$	= Utilization factor; accounting for the difference between DIY and trained volunteer installation of measures. It is understood that there will be more unused caulk in DIY installations, as opposed to trained volunteers that take partially used tubes of caulk and utilize them in secondary sites.
$EFLH_{cooling}$	= Cooling equivalent full-load hours
CF	= Coincidence Factor
1.08	= Specific heat of air x density of inlet air @ 70ºF x 60 min/hr, in BTU/h-ºF-CFM[1]
24	= Hours in one day
1,000	= Conversion factor, one kW equals 1,000 watts
3,412	= Conversion factor, one kWh equals 3,412 BTU
1,000,000	= Conversion factor, one MMBtu equals 1,000,000 BTU

[1] The sensible heat constant at standard conditions of 1.08 is applied in accordance with standard HVAC industry practice. While the underlying assumptions are not representative characteristics of a NY heating season, the impacts to this value due to average heating season temperature and NY mean elevation offset such that the NY heating season specific value is approximately 1.08.

Summary of Variables and Data Sources

Variable	Value	Notes
ΔCFM/ft		Look up from CFM Reduction of Weatherization Methods table below based on weatherization product per linear foot.[2]
ft		From application. If unknown use default values based on weatherization product in the Default Lengths of Weatherization Measures Table below.[3] Because this measure is intended primarily for customer installations, the values in the Default Lengths of Weatherization Measures Table below shall serve as application maximum values.
CDD		Lookup from table below based on location.[4] For midstream programs, use the location of the participating store.[5]
HDD		Lookup from table below based on location.[6] For midstream programs, use the location of the participating store.[7]
SEER		From application. Use SEER2 rating if equipment has a SEER2 rating. If unknown use 13.4 SEER2, assuming a minimally code compliant, 3-ton, split system AC.[8]
COP		From application, otherwise use 3.22.[9]
$Eff_{FuelHeat}$		From application. If unknown, use 80%, assuming a minimally code compliant, 72 kBTU/h gas furnace.[10]
$F_{ElecCool}$	Electric Cooling: 1 No Electric Cooling: 0 Unknown: 0.43	Based on EIA Residential Energy Consumption Survey (RECS) 2020 for Middle Atlantic States.[11]

[2] KEMA Final Report, Evaluation of the Weatherization Residential Assistance Partnership (WRAP) and Helps Programs, Middletown, CT, 9/10/2010, Page 3-12, Table 5.
[3] Survey of caulk, rope caulk, and door sweep products from the Lowe's and Home Depot websites – Harold Neale, NYSEG/RG&E, November 2022
[4] NOAA National Centers for Environmental Information – NCEI 1991-2020 Climate Normals
[5] NYSERDA Monthly Cooling and Heating Degree Day Data
[6] NOAA National Centers for Environmental Information – NCEI 1991-2020 Climate Normals
[7] NYSERDA Monthly Cooling and Heating Degree Day Data
[8] 10 CFR 430.32(c) (5)
[9] E-mail response from ICF regarding the average COP of residential heat pumps installed with NY Clean Heat Incentives, 11/1/2022
[10] 10 CFR 430.32(e)(2)(iii)(A)
[11] EIA Residential Energy Consumption Survey (RECS) 2020 for Middle Atlantic States, Table HC7.7 ("Unknown" calculated as the number of homes with central AC divided by the total number of homes).

Variable	Value	Notes
$F_{ElecHeat}$	Electric Heating: 1 No Electric Heating: 0 Unknown: 0.19	Based on EIA Residential Energy Consumption Survey (RECS) 2020 for Middle Atlantic States.[12]
$F_{FuelHeat}$	Fossil Fuel Heating: 1 No Fossil Fuel Heating: 0 Unknown: 0.61	Based on EIA Residential Energy Consumption Survey (RECS) 2020 for Middle Atlantic States.[13]
$F_{Utilization}$		Use 0.5 for trained volunteers, or 0.2 for DIY or unknown applications.[14]
$EFLH_{cooling}$		Lookup based on building type, vintage and location from Appendix G.
CF	0.69	

CFM Reduction of Weatherization Measures

Measure	Units	ΔCFM/ft
Other weather stripping or gap sealant	Per linear foot	0.23[15]

The length of weatherization measures applied comes from the application. If that information is unavailable, use the default value in the below table. Because this measure is intended primarily for customer installations, the values below shall serve as application maximum values.

Default Lengths of Weatherization Measures

Measure	Units	Length per Measure (ft)
Liquid Caulk	Per linear foot	55[16]

[12] EIA Residential Energy Consumption Survey (RECS) 2020 for Middle Atlantic States, Table HC6.7 ("Unknown" calculated as the number of homes with electric heat divided by the total number of homes).
[13] EIA Residential Energy Consumption Survey (RECS) 2020 for Middle Atlantic States, Table HC6.7 ("Unknown" calculated as the number of homes with natural gas heat divided by the total number of homes).
[14] Anecdotally, trained volunteers are installing between 80 and 90% of caulk through the "Operation Weatherize" initiative. Values selected here are conservative to emphasize need for revision through future evaluation.
[15] KEMA Final Report, Evaluation of the Weatherization Residential Assistance Partnership (WRAP) and Helps Programs, Middletown, CT, 9/10/2010, Page 3-12, Table 5.
[16] Survey of caulk, rope caulk, and door sweep products from the Lowe's and Home Depot websites – Harold Neale, NYSEG/RG&E, November 2022

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.69.[17]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is any gap in the building envelope that is allowing outside air inside the dwelling.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is the application of a weatherization product to a gap in the building envelope that prevents outside air from entering the dwelling.

Operating Hours

Effective heating and cooling hours associated with benefits of weatherization measures are established via the Heating Degree Days presented below.

Heating and Cooling Degree Days[18]

City	HDD	CDD
Albany	6,391	721
Binghamton	7,200	383
Buffalo	6,502	607
Massena	8,030	406
NYC	4,900	1017
Poughkeepsie	6,026	745
Syracuse	6,625	618

Example Calculation *(Not to be used as default)*

A standard tube of caulk was purchased at a hardware store located near Albany, NY for DIY installation. We are unsure if the home has air conditioning, or how the home is heated. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below.

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = \frac{1.08 \times \frac{\Delta CFM}{ft} \times ft \times CDD \times 24}{SEER \times 1{,}000} \times F_{ElecCool} \times F_{Utlization}$$

[17] 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 TRM Management Committee.

[18] HDD/CDD taken from NCEI 1991-2020 climate normal using a 65 °F balance point.

$$\Delta kWh_{heating} = \frac{1.08 \times \frac{\Delta CFM}{ft} \times ft \times HDD \times 24}{COP \times 3{,}412} \times F_{ElecHeat} \times F_{Utlization}$$

$$\Delta kW = \frac{\Delta kWh_{cooling}}{EFLH_{cooling}} \times CF$$

$$\Delta MMBtu = \frac{1.08 \times \frac{\Delta CFM}{ft} \times ft \times HDD \times 24}{Eff_{FuelHeat} \times 1{,}000{,}000} \times F_{FuelHeat} \times F_{Utlization}$$

ΔCFM/ft = 0.23 per linear foot, from CFM Reduction of Weatherization Measures table
ft = 55, from Default Lengths of Weatherization Measures Table
CDD = 721, from the Heating and Cooling Degree Days table based on location
HDD = 6,391, from the Heating and Cooling Degree Days table based on location
SEER = 13.4, from Summary of Variables and Data Sources table
COP = 3.22, from Summary of Variables and Data Sources
$Eff_{EuelHeat}$ = 0.80, from Summary of Variables and Data Sources table
$F_{ElecCool}$ = 0.43, from Summary of Variables and Data Sources table
$F_{ElecHeat}$ = 0.19, from Summary of Variables and Data Sources table
$F_{FuelHeat}$ = 0.61, from Summary of Variables and Data Sources table
$F_{Utilization}$ = 0.2, from Summary of Variables and Data Sources table, based on DIY installation
$EFLH_{cooling}$ = 358, from Appendix G based on housing type, building vintage, and location from application
CF = 0.69, from Summary of Variables and Data Sources table

$$\Delta kWh_{cooling} = \frac{1.08 \times 0.23 \times 55 \times 721 \times 24}{13.4 \times 1{,}000} \times 0.43 \times 0.2 = 1.5\ kWh$$

$$\Delta kWh_{heating} = \frac{1.08 \times 0.23 \times 55 \times 6{,}391 \times 24}{3.22 \times 3{,}412} \times 0.19 \times 0.2 = 7.2\ kWh$$

$$\Delta kWh = \Delta kWh_{heating} + \Delta kWh_{cooling} = 8.7\ kWh$$

$$\Delta kW = \frac{1.5}{358} \times 0.69 = 0.003\ kW$$

$$\Delta MMBtu = \frac{1.08 \times 0.23 \times 55 \times 6{,}391 \times 24}{0.80 \times 1{,}000{,}000} \times 0.61 \times 0.2 = 0.32\ MMBtu$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. KEMA Final Report, Evaluation of the Weatherization Residential Assistance Partnership (WRAP) and Helps Programs, Middletown, CT, 9/10/2010, Page 3-12, Table 5.
2. NOAA National Centers for Environmental Information – NCEI 1991-2020 Climate Normals Available from: https://www.ncdc.noaa.gov/cdo-web/datatools/normals
3. NYSERDA Monthly Cooling and Heating Degree Day Data, New York State – Statewide Total Degree Day Normal values for both Heating and Cooling Degree Days: Monthly Cooling and Heating Degree Day Data - NYSERDA
4. E-mail response from ICF regarding the average COP of residential heat pumps installed with NY Clean Heat Incentives, 11/1/2022.
5. Survey of caulk, rope caulk, and door sweep products from the Lowe's and Home Depot websites – Harold Neale, NYSEG/RG&E, November 2022.
6. EIA Residential Energy Consumption Survey (RECS) 2020 Survey Data for Middle Atlantic States.
   Available from: https://www.eia.gov/consumption/residential/data/2020/
7. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=dfe00d44cfd9ab9ead4019d69702652a&mc=true&node=pt10.3.430&rgn=div5#se10.3.430_132
8. BG&E: Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.

Record of Revision

Record of Revision Number	Issue Date
9-24-1	10/22/2024

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BUILDING SHELL

DUCT SEALING AND INSULATION

Measure Description

This measure covers the installation of sealing and insulation of the space heating and air conditioning duct distribution system in the unconditioned spaces of single-family and multi-family homes. Duct sealing and insulation reduces air and thermal leakage into unconditioned and outdoor spaces, improving system efficiency. Sealing and insulation installed under this measure shall meet or exceed all applicable construction code requirements. This measure is only applicable in existing buildings. Only ductwork located in unconditioned spaces is eligible for savings.

This measure shall be implemented with the assistance of a duct-blaster test on the distribution system pre- and post-implementation. A duct blaster test, similar in concept to a whole-house blower door test, is turned on to pressurize the duct system to 25 Pascals (a pressure which represents typical operating pressures for forced-air systems). The airflow through the duct blaster fan (which is displayed in cfm on the duct blaster's manometer) equals the flow escaping through leaks in the duct system. The results are reported as "cfm @ 25 Pascals".

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

For AC and HP Units with Capacity <65,000 BTU/h

$$\Delta kWh = \frac{l_{duct,uncond}}{l_{duct}} \times \left\{ \left[tons \times \frac{12}{SEER} \times EFLH_{cooling} \times \left(1 - \frac{Eff_{dist,cooling,baseline}}{Eff_{dist,cooling,ee}} \right) \times \left(1 - TRF_{cooling} \right) \right] + \left[kBTU/h_{out} \times \frac{1}{HSPF} \times EFLH_{heating} \times \left(1 - \frac{Eff_{dist,heating,baseline}}{Eff_{dist,heating,ee}} \right) \times \left(1 - TRF_{heating} \right) \right] \right\}$$

For AC and HP Units with Capacity ≥65,000 BTU/h

$$\Delta kWh = \frac{l_{duct,uncond}}{l_{duct}} \times \left\{ \left[tons \times \frac{12}{IEER} \times EFLH_{cooling} \times \left(1 - \frac{Eff_{dist,cooling,baseline}}{Eff_{dist,cooling,ee}} \right) \times \left(1 - TRF_{cooling} \right) \right] + \left[\frac{kBTU/h_{out}}{3.412} \times \frac{1}{COP} \times EFLH_{heating} \times \left(1 - \frac{Eff_{dist,heating,baseline}}{Eff_{dist,heating,ee}} \right) \times \left(1 - TRF_{heating} \right) \right] \right\}$$

For Electric Furnaces

$$\Delta kWh = \frac{l_{duct,uncond}}{l_{duct}} \times kW_{in} \times EFLH_{heating} \times \left(1 - \frac{Eff_{dist,heating,baseline}}{Eff_{dist,heating,ee}} \right) \times \left(1 - TRF_{heating} \right)$$

Summer Peak Coincident Demand Savings

For AC and HP Units

$$\Delta kW = \frac{l_{duct,uncond}}{l_{duct}} \times tons/unit \times \frac{12}{EER} \times \left(1 - \frac{Eff_{dist,cooling,baseline}}{Eff_{dist,cooling,ee}}\right) \times (1 - TRF_{cooling}) \times CF$$

Annual Fossil Fuel Energy Savings

For Fossil Fuel-Fired Furnaces

$$\Delta MMBtu = \frac{l_{duct,uncond}}{l_{duct}} \times \frac{kBTU/h_{in}}{1{,}000} \times EFLH_{heating} \times \left(1 - \frac{Eff_{dist,heating,baseline}}{Eff_{dist,heating,ee}}\right) \times (1 - TRF_{heating})$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
tons	= Total output cooling capacity of impacted system, in tons (at AHRI standard rating conditions)
$kBTU/h_{out}$	= Total output heating capacity of impacted system, in kBTU/h (at AHRI standard high-temperature rating conditions)
kW_{in}	= Total input heating capacity of impacted system, in kW
$kBTU/h_{in}$	= Total input heating capacity of impacted system, in kBTU/h (at AHRI standard high-temperature rating conditions)
$l_{duct,uncond}$	= Total length of ductwork in each unconditioned space, in linear feet
l_{duct}	= Total length of ductwork, in linear feet
TRF	= Thermal Regain Factor
SEER	= Seasonal energy efficiency ratio in BTU/watt-hour. Total cooling output of an air conditioner during its normal annual usage period for cooling in BTU, divided by the total electric energy input during the same period in watt-hours
IEER	= Integrated energy efficiency ratio in BTU/watt-hour. A weighted calculation of mechanical cooling efficiencies at full load and part load AHRI standard rating conditions
EER	= Energy efficiency ratio under peak conditions in BTU/watt-hour. Measurement of the cooling capacity for a unit in BTU/h divided by the connected electric power of the unit in watts (at AHRI standard rating conditions)
HSPF	= Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric strip heat) during the heating season divided by the total electric energy heat pump consumed in watt-hours
COP	= Coefficient of performance, ratio of output energy/input energy (at AHRI standard high-temperature rating conditions)
$EFLH_{cooling}$	= Cooling equivalent full-load hours
$EFLH_{heating}$	= Heating equivalent full-load hours
baseline	= Characteristic of baseline condition
ee	= Characteristic of energy efficient condition
cooling	= Characteristic of cooling condition

$_{heating}$ = Characteristic of heating condition
Eff_{dist} = Distribution system efficiency
CF = Coincidence factor
12 = (kBTU/h)/ton of air conditioning capacity
3.412 = Conversion factor, one watt-hour equals 3.412 BTU
1,000 = Conversion factor, one MMBtu equals 1,000 kBTU

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application.
$kBTU/h_{out}$		From application.
kW_{in}		From application.
$kBTU/h_{in}$		From application.
$L_{duct, uncond}$		From application.
L_{duct}		From application.
$TRF_{cooling}$		See table in the Thermal Regain Factor section below.
$TRF_{heating}$		See table in the Thermal Regain Factor section below.
SEER		Existing equipment nameplate SEER. For equipment rated in SEER2, SEER2 rating shall be used.
IEER		Existing equipment nameplate IEER.
EER		Existing equipment nameplate EER. For equipment rated in EER2, EER2 rating shall be used.
HSPF		Existing equipment nameplate HSPF. For equipment rated in HSPF2, HSPF2 rating shall be used.
COP		Existing equipment nameplate COP.
$EFLH_{heating}$		Look up based on building type, vintage and location from Appendix G.
$EFLH_{cooling}$		Look up based on building type, vintage and location from Appendix G.
$Eff_{dist,cooling,baseline}$		Look up in Appendix H for uninsulated duct system based on building type, location and duct leakage in cooling mode. For duct leakage values that fall between two values in Appendix H, interpolation is acceptable.
$Eff_{dist,heating,baseline}$		Look up in Appendix H for uninsulated duct system based on building type, location and duct leakage in heating mode. For duct leakage values that fall between two values in Appendix H, interpolation is acceptable.
$Eff_{dist,cooling,ee}$		Look up in Appendix H for R-6 insulated duct system based on building type, location and duct leakage in cooling mode. For duct leakage values that fall between two values in Appendix H, interpolation is acceptable.

Variable	Value	Notes
$Eff_{dist,heating,ee}$		Look up in Appendix H for R-6 insulated duct system based on building type, location and duct leakage in cooling mode. For duct leakage values that fall between two values in Appendix H, interpolation is acceptable.
CF	0.69	

Thermal Regain Factor[19]
Some energy loss from poorly sealed and insulated ducts can be regained through conduction back into conditioned spaces. The table below lists default thermal regain factors depending on the location of the ductwork. Ductwork in garages, crawl spaces, and under slabs should be treated as Unconditioned Basement for Appendix H lookup.

Duct Location	$TRF_{cooling}$	$TRF_{heating}$
Attic	0.10	0.10
Garage	0.10	0.10
Crawl space, unvented, uninsulated	0.60	0.60
Crawl Space, Unvented, Insulated Building Floor and Crawl Space walls	0.60	0.30
Crawl Space, Unvented, Insulated Floor Only	0.30	0.30
Crawl Space, Vented, Uninsulated	0.60	0.55
Crawl Space, Insulated Building Floor and Crawl Space Walls	0.63	0.60
Crawl Space, Vented, Insulated Floor Only	0.30	0.30
Basement, Uninsulated	0.50	0.50
Basement, Insulated Walls	0.60	0.60
Under-slab	0.20	0.20

For duct systems in multiple unconditioned spaces, evaluate the ductwork in each space separately and sum together to calculate the total energy savings. For each equation, use the length of the insulated ductwork specific to each unconditioned space.

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.69.[20]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a ducted HVAC system with insufficient sealing and insulation that has undergone duct-blaster testing. Look up baseline uninsulated distribution system efficiency from

[19] Home Energy Saver & Score: Engineering Documentation, Thermal Distribution Efficiency.
[20] 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 TRM Management Committee.

Appendix H based on building type, location and duct total leakage. For duct leakage values that fall between two values in Appendix H, interpolation is acceptable.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a sealed and insulated duct system in a retrofit application that has undergone post-implementation duct-blaster testing. Supply and return ducts shall be insulated to a minimum of R-8 where three inches in diameter or greater, and R-6 where less than three inches in diameter. Total leakage shall be less than or equal to four cubic feet per minute per 100 ft^2 of conditioned floor area.[21]

Look up compliance distribution system efficiency from Appendix H based on building type, location and duct total leakage from duct blaster test. Models for HVAC distribution efficiency with R-8 insulation are currently under development; values associated with R-6 shall be used until R-8 data become available.

Operating Hours

Cooling and heating equivalent full-load hours were calculated from a DOE-2.2 simulation of prototypical single and multi-family residential buildings. Operating hour assumptions for the prototypical building models are described in Appendix A. The heating EFLH for residential buildings in NY are shown in Appendix G.

Example Calculation *(Not to be used as default)*

Duct sealing rated at R-6 is installed on 15 feet of a 6" diameter duct system of a vented crawl space under an insulated floor in a single-family home located near Albany. The total length of ductwork is 15 feet. A duct-blaster test conducted prior to implementation indicates total duct leakage of 25% and follow up duct-blaster test conducted post implementation indicates a total duct leakage of 15%. The home has a 3-ton central electric cooling system with 15 SEER and 12 EER and a 70 kBTU/h gas furnace with 82% AFUE. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below. Since electric heating is not present, terms related to electric heating impacts are represented as "N/A."

$$\Delta kWh = \frac{l_{duct,uncond}}{l_{duct}} \times \left\{ \left[tons \times \frac{12}{SEER} \times EFLH_{cooling} \times \left(1 - \frac{Eff_{dist,cooling,baseline}}{Eff_{dist,cooling,ee}} \right) \times \left(1 - TRF_{cooling} \right) \right] + N/A \right\}$$

[21] ECCCNYS 2020, R403.3.1 & R403.3.4.

$$\Delta kW = \frac{l_{duct,uncond}}{l_{duct}} \times tons/unit \times \frac{12}{EER} \times \left(1 - \frac{Eff_{dist,cooling,baseline}}{Eff_{dist,cooling,ee}}\right) \times (1 - TRF_{cooling}) \times CF$$

$$\Delta MMBtu = \frac{l_{duct,uncond}}{l_{duct}} \times \frac{kBTU/h_{in}}{1{,}000} \times EFLH_{heating} \times \left(1 - \frac{Eff_{dist,heating,baseline}}{Eff_{dist,heating,ee}}\right) \times (1 - TRF_{heating})$$

$l_{duct,uncond}$ = 15, from application
l_{duct} = 15, from application
tons = 3, from application
SEER = 15, from application
$EFLH_{cooling}$ = 358, from Appendix G based on housing type, building vintage, and location from application
$Eff_{dist,cooling,baseline}$ = 0.960, from Appendix H based on duct-blaster test leakage and location
$Eff_{dist,cooling,ee}$ = 0.972, from Appendix H based on duct-blaster test leakage and location
$TRF_{cooling}$ = 0.3, from on Thermal Regain Factor based on insulation location
EER = 12, from application
CF = 0.69, from Summary of Variables and Data Sources table
$kBTU/h_{in}$ = 70, from application
$EFLH_{heating}$ = 933, from Appendix G based on housing type, building vintage, and location from application
$Eff_{dist,heating,baseline}$ = 0.953, from Appendix H based on duct-blaster test leakage and location
$Eff_{dist,heating,ee}$ = 0.968, from Appendix H based on duct-blaster test leakage and location
$TRF_{heating}$ = 0.3, from on Thermal Regain Factor based on insulation location

$$\Delta kWh = \frac{15}{15} \times \left\{\left[3 \times \frac{12}{15} \times 358 \times \left(1 - \frac{0.960}{0.972}\right) \times (1 - 0.3)\right] + 0\right\} = 7.42 \ kWh$$

$$\Delta kW = \frac{15}{15} \times 3 \times \frac{12}{12} \times \left(1 - \frac{0.960}{0.972}\right) \times (1 - 0.3) \times 0.69 = 0.018 \ kW$$

$$\Delta MMBtu = \frac{15}{15} \times \frac{70}{1{,}000} \times 933 \times \left(1 - \frac{0.953}{0.968}\right) \times (1 - 0.3) = 0.708 \ MMBtu$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. Home Energy Saver & Score: Engineering Documentation, Thermal Distribution Efficiency.
   Available from: http://hes-documentation.lbl.gov/calculation-methodology/calculation-of-energy-consumption/heating-and-cooling-calculation/thermal-distribution-efficiency/thermal-distribution-efficiency
2. BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.
3. ECCCNYS 2020 R403.3.1: Insulation (Prescriptive) & R403.3.4: Duct Leakage (Prescriptive).
   Available from: https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-re-residential-energy-efficiency

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
6-18-5	6/26/2018
9-24-2	10/22/2024

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LIGHTING

INTERIOR AND EXTERIOR LIGHTING

Measure Description

This measure covers energy efficient lighting equipment, such as energy efficient lamps, LED lamps and improved lighting fixtures installed in interior or exterior locations. These technologies, taken separately or combined into an energy efficient lighting fixture, provide the required illumination at reduced input power.

Beginning January 2012 and phased in through January 2014, the Energy Independence and Security Act of 2007 (EISA) regulations stipulated typical screw-based general service lamps (GSLs) with wattages ranging from 40W to 100W to comply with new lamp wattage standards such that the range of wattages decreased to be from 29W to 72W for rated lumen output ranging from 310 to 2,600 lumens.[22,23] A backstop provision was included in this legislation that would require general service lamps to meet a minimum efficacy of 45 lumens per watt beginning on 1/1/2020 in the absence of a final rule amending GSL standards.[24] Additionally in 2017, final rulings were promulgated expanding GSL and GSIL definitions to eliminate exceptions for certain specialty lamps, reflector lamps and decorative lamps effective 1/1/2020.[25,26] The backstop provision and revised definitions rulings were withdrawn prior to their effectuation date and subsequently reinstated by DOE with phased enforcement between January 2023 and July 2023.[27,28] As such, baseline values for market rate applications of this measure shall apply wattages in accordance with revised GSL and GSIL definitions and the imposed 45 lumen per watt standard established via these rulings. Where existing conditions are available, LMI applications of the primary method prescribed below shall establish baseline wattage aligned with existing conditions.

This measure consists of two methods for estimating energy and demand savings. The primary method represented by the first set of algorithms below is suitable for both market rate and LMI applications. The alternative methodology represented by the second set of algorithms shall be used for LMI applications only. This simplified approach relies on average sampling data to establish wattage and consumption reductions and assumed hours of operation. It is only applicable for LMI projects consisting of 16 LED lamps or fewer. Projects exceeding this limit require a lighting schedule.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

[22] The maximum rated wattage varies for modified spectrum lamps.
[23] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 86.
[24] 42 U.S.C. 6295(i)(6)(A)(v).
[25] DOE 82 FR 7276.
[26] DOE 82 FR 7322.
[27] DOE 87 FR 27439.
[28] DOE 87 FR 27461.

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_{ff}$$

Alternate Method for Calculating Annual Energy Savings for LMI Projects[29]

This methodology for claiming savings is an alternate method that is being tested for future use and will be evaluated for use in both Market-Rate and LMI households.

General Purpose LEDs

$$\Delta kWh = units \times \left(\frac{\Delta W_{LMI,GP} \times 365}{1{,}000}\right) \times hrs$$

Candelabra LEDs[30]

$$\Delta kWh = units \times \Delta kWh_{LMI,Candelbra}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
baseline	= Characteristic of baseline condition
ee	= Characteristic of energy efficient condition
W	= Rated wattage of lamp and/or fixture (Watts)

[29] The average wattage reduction per lamp is taken to be 46 watts for A-lamps and 33 watts for candelabra type lamps. The first lamp operating hours for A-lamps prescribed in the Operating Hours section below were determined from the same study used to derive the standard method operating hours. The additional lower hours for larger quantities of A-lamp LEDs are from various sources.

[30] It is assumed that the ΔkWh per Candelabra lamp is 42.2 kWh. This is derived from an assumed ΔW of 33W per lamp and 3.5 hours of usage per day. The savings associated with candelabra lamps is derived from a baseline lamp wattage that is pre-EISA 2020 adjustments. The 2007 baseline maximum for candelabra lamps in EISA states that the wattage cannot exceed 60 watts.

hrs = Lighting operating hours
$HVAC_c$ = HVAC interaction factor for annual electric energy consumption
$HVAC_d$ = HVAC interaction factor at utility summer peak hour
HVACff = HVAC interaction factor for annual fossil fuel consumption (MMBtu/kWh)
CF = Coincidence factor
$\Delta W_{LMI,GP}$ = Wattage reduction per general-purpose lamp (LMI only)
$\Delta kWh_{LMI,Candelabra}$ = Annual electric energy savings per candelabra lamp (LMI only)
1,000 = Conversion factor, one kW equals 1,000 Watts
365 = Days per year

Summary of Variables and Data Sources

Variable	Value	Notes
$W_{baseline}$		Baseline measure watts, from appropriate "Baseline Efficiencies" section below. If applying the primary method in an LMI application, in situ wattage may be used in place of assumed baseline wattage. If the existing wattage is not known for an LMI application, use the "Midstream/Upstream Applications for General Service Lamps" subsection below. For detailed definitions, refer to the NOTE in the "Baseline Efficiency" section.
W_{ee}		Energy efficient measure watts, from application
hrs		Look up in Operating Hours section below based on project type, installation type and location. "Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting. "Unknown" is not a valid selection for direct install programs. LMI projects may claim up to 16 LED lamps before requiring a lighting schedule.
$HVAC_c$	Exterior and Unconditioned Spaces: 0	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	Exterior and Unconditioned Space: 0	HVAC interaction factor for peak demand at utility summer peak hour (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_{ff}$	Exterior and Unconditioned Space: 0	HVAC interaction factor for annual fossil fuel energy consumption (MMBtu/kWh). Vintage and HVAC type weighted average by city. See Appendix D.
CF	Interior: 0.16 Exterior: 0	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

Variable	Value	Notes
$\Delta W_{LMI,GP}$	46	Wattage reduction per general-purpose lamp.[31]
$\Delta kWh_{LMI,Candelabra}$	42.2	This is derived from an assumed ΔW of 33W per lamp and 3.5 hours of usage per day.

HVAC system interaction factors are defined as the ratios of the cooling energy and demand reduction and heating energy increase per unit of lighting energy reduction. Much of the input energy for lighting systems is converted to heat that must be removed by the HVAC system. Reductions in lighting heat gains due to lighting power reduction decrease the need for space cooling and increase the need for space heating.

HVAC interaction factors vary by climate, HVAC system type and building type. Prescribed values for HVAC interaction factors for lighting energy and peak demand savings are shown in Appendix D. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0.

Coincidence Factor (CF)

The prescribed value for the coincidence factor for interior lighting is 0.16.[32] This value shall also be used if the installation location is unknown.

Because exterior lighting is assumed to operate during off-peak hours only, the prescribed coincidence factor for exterior lighting is 0.0.

Baseline Efficiencies from which Energy Savings are Calculated

NOTE: For the purposes of establishing baseline efficiencies for this measure, "Downstream" encompasses any program delivery mechanism that allows for the determination of housing type (Market Rate vs. LMI) and, in the case of LMI programs, existing lamp wattage. "Midstream/Upstream" baselines are intended for program delivery mechanisms where housing type cannot be identified or for LMI programs where existing lamp wattage cannot be identified.

Downstream Market Rate Applications for General Service Lamps

In accordance with DOE final rules published in May 2022, baseline wattage for General Service Lamps (GSLs) (as defined in DOE 87 FR 27461)[33] in market rate applications shall be established

[31] A sampling of recorded pre- and post- wattage of 100 completed EmPower projects, Data reported by a New York City agency (AEA), Inspections completed by Nexant, during a program evaluation ("M&V Evaluation EmPower New York℠ Program," March 2007)., EmPCalc Honeywell Narrative 10_04_16 10 AM.

[32] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table 4-4: Peak Period Coincidence Factors and Confidence Intervals – Efficient Bulbs. CF referenced reflects Average Summer for NYSERDA based on ISO-NE peak period. The NYSERDA model includes UNY and DNY. The NYSERDA model does not differentiate between interior and exterior lighting. The interior lighting sample size is significantly larger than the exterior sample size. Thus, reported Coincidence Factor is appropriate for interior lighting and unknown installations.

[33] DOE 87 FR 27461.

based on a minimum standard efficacy of 45 lumens per watt.[34] Baseline wattage shall be derived as follows:

$$W_{baseline} = \frac{Lumens_{ee}}{45}$$

where:

$W_{baseline}$	= Baseline lamp wattage
$Lumens_{ee}$	= Rated light output of efficient lamp
45	= Minimum lumens per watt standard established by DOE final rule

Downstream Market Rate Applications for Exempt Lamps

A general service lamp, as defined in the Code of Federal Regulations, is a lamp, including but not limited to general service incandescent lamps, compact fluorescent lamps, general service light-emitting diode lamps, and general service organic light emitting diode lamps used in general light-ing applications that:

(1) Has an ANSI base;
(2) Is able to operate at a voltage of 12 volts or 24 volts, at or between 100 to 130 volts, at or between 220 to 240 volts, or of 277 volts for integrated lamps, or is able to operate at any voltage for non-integrated lamps;
(3) Has an initial lumen output of greater than or equal to 310 lumens (or 232 lumens for modified spectrum general service incandescent lamps) and less than or equal to 3,300 lumens;
(4) Is capable of being operated at voltage range at least partially within 110 and 130 volts.

Certain lamp types were exempt from the original EISA legislation and subsequent final rule amending the definition of GSLs, though several exemptions were discontinued in the latter. For a complete list and definitions of exempt lamp types, as well as discussion of discontinued and maintained exemptions, reference final rules 82 FR 7276 and 82 FR 7322.[35,36]

For products that are not governed by the 45 lumen per watt standard (i.e., do not meet the defini-tion of general service lamp or fall under an exempt product category), the baseline wattage shall be established per manufacturer recommended baseline wattage. By default, a 45 lumen per watt baseline shall be applied.

Midstream/Upstream Applications for General Service Lamps

Due to lack of availability of customer and existing conditions data in midstream and upstream program delivery mechanisms and the blend of market rate and LMI customer participation in these programs, distinct baseline guidance for these program types that endeavors to account for the proportion of LMI participants across NY state has been developed. The intent of this guidance is a blended baseline applying a 45 lumen per watt standard for market rate participants and an approximated existing condition baseline across the LMI participant population. For the purposes

[34] DOE 87 FR 27439.
[35] DOE 82 FR 7276.
[36] DOE 82 FR 7322.

of this exercise, the approximated existing condition baseline for LMI customers was assumed to align with baselines established for residential lighting prior to the effectuation of the 45 lumen per watt backstop.

Evaluation of 2021 retail LED bulb sales suggest that approximately 37% of residential LEDs are purchased by LMI customers.[37] As such, the baselines prescribed for midstream and upstream applications in the tables below apply a weighting reflecting 37% LMI and 63% market rate participation.

The baselines established below are applicable to midstream and upstream programs as well as downstream LMI programs where the primary calculation methodology above is utilized and existing lamp wattage cannot be collected. For lamps that are not covered by the tables below, either based on bulb type or lumen output, the manufacturer recommended baseline wattage should be used.

Standard Lamps

Bulb Type (a)	**Lumen Range (b)**	**$W_{baseline}$ (c)**
A-Lamp (A15, A17, A19, A21)	< 310	Use manufacturer recommended baseline wattage or assume 45 lm/W
	310 – 749	22
	750 – 1,049	35
	1,050 – 1,489	46
	1,490 – 2,600	66
	> 2,600	Use manufacturer recommended baseline wattage or assume 45 lm/W

Specialty Lamps

Baseline wattage for specialty lamps are found in the table below. Specialty lamps are defined as screw-base lamps that are globe, bullet, candle or decorative shaped. These can be medium base, intermediate base, or candelabra base lamps.

Bulb Type (a)	**Base Type (b)**	**Lumen Range (c)**	**$W_{baseline}$ (d)**
Globe All G (G30, G25, G16.5)	E26 and E17	< 90	Use manufacturer recommended baseline wattage or assume 45 lm/W
		90 – 179	6
		180 – 249	10
		250 – 349	13

[37] Cadmus & Demand Side Analytics, "Residential Retail Lighting Impact Evaluation Final Report", Prepared for Central Hudson, April 20, 2022 – Slide 33.

Bulb Type (a)	Base Type (b)	Lumen Range (c)	$W_{baseline}$ (d)
		350 – 749	22
		750 – 1,049	29
		1,050 – 1,489	37
		1,490 – 2,600	55
		> 2,600	Use manufacturer recommended baseline wattage or assume 45 lm/W
	E12 (Candelabra)	< 90	Use manufacturer recommended baseline wattage or assume 45 lm/W
		90 – 179	6
		180 – 249	10
		250 – 349	13
		350 – 499	21
		500 – 1,049	33
		> 1,049	Use manufacturer recommended baseline wattage or assume 45 lm/W
Globe (G40)	E26 (Medium), E17, and E12	< 90	Use manufacturer recommended baseline wattage or assume 45 lm/W
		90 – 179	6
		180 – 249	10
		250 – 349	13
		350 – 499	21
		500 – 1,049	33
		> 1,049	Use manufacturer recommended baseline wattage or assume 45 lm/W
Decorative (Shapes B10, B11, B13, BA10, BA11, CA10, C7, C9, F10, F15, ST, S14)	E26 (Medium) and E17	< 70	Use manufacturer recommended baseline wattage or assume 45 lm/W
		70 – 89	5
		90 – 149	7
		150 – 299	12
		300 – 749	22
		750 – 1,049	29
		1050 – 1,489	37
		1,490 – 2,600	55
		> 2,600	Use manufacturer recommended baseline wattage or assume 45 lm/W

Bulb Type (a)	Base Type (b)	Lumen Range (c)	$W_{baseline}$ (d)
	Candelabra base E12	< 70	Use manufacturer recommended baseline wattage or assume 45 lm/W
		70 – 89	5
		90 – 149	7
		150 – 299	12
		300 – 449	20
		450 – 1,049	33
		> 1,049	Use manufacturer recommended baseline wattage or assume 45 lm/W

Reflector/Flood Lamps

Baseline wattage for reflector and flood type lamps are found in the table below. For reflector and flood lamps that are not covered by the table below, either based on bulb type or lumen output, the manufacturer recommended baseline wattage should be used.

Bulb Type (a)	Lumen Range (b)	$W_{baseline}$ (c)
R20	200 - 299	15
	300 – 718	24
	719 – 810	29
	811 – 1,002	33
	1,003 – 1,202	39
	1,203 – 1,516	47
	1,517 – 1,733	56
	1,734 – 2,184	64
	> 2,184	75
PAR20	200 - 299	15
	300 – 718	22
	719 – 810	29
	811 – 1,002	33
	1,003 – 1,202	39
	1,203 – 1,516	47
	1,517 – 1,733	56
	1,734 – 2,184	64
	> 2,184	75
BR30, BR40, ER40	200 – 299	15
	300 – 399	20
	400 – 649	26
	650 – 1,419	39
	1,420 – 1,789	50
	1,790 – 2,045	60

Bulb Type (a)	Lumen Range (b)	$W_{baseline}$ (c)
	2,046 – 2,578	69
	> 2,578	80
ER30	200 – 299	15
	300 – 399	20
	400 – 956	28
	957 – 1183	35
	1184 – 1419	42
	1420 – 1789	50
	1790 – 2045	60
	2046 – 2578	69
	> 2578	80
PAR30, PAR38, R40	639 – 847	25
	848 – 956	31
	957 – 1,183	35
	1,184 – 1,419	42
	1,420 – 1,789	50
	1,790 – 2,045	60
	2,046 – 2,578	69
	> 2,578	80
R14, PAR16, R16	200 – 299	15
	300 – 399	20
	400 – 499	25
	500 – 599	30
	600 – 1,000	35
MR16	< 450	19
	450 – 600	26
	> 600	36
For any lamps/bulb types for reflector lamps not captured in the criteria above	All	Use manufacturer recommended baseline wattage or assume 45 lm/W

Compliance Efficiency from which Incentives are Calculated

The compliance condition for individual fixture/lamp replacement scenarios is an efficient lighting product (lamp or fixture) meeting the minimum requirements of the current effective version of Design Lights Consortium qualified products list or the minimum efficacy (lm/W) ratings based on Lamp / Fixture Type per the table below.[38]

[38] ENERGY STAR Program Requirements for Luminaires - Eligibility Criteria Version 2.2, August 15, 2019 & ENERGY STAR Program Requirements for Lamps - Eligibility Criteria Version 2.1, June 2, 2022

Product categories/applications covered by DLC must meet all DLC qualified product technical specifications. Only products not covered by DLC shall be qualified based on minimum efficacy in provided table.

Lamp / Fixture Type	Minimum Efficacy (lm/W)
Omnidirectional Lamp w/ CRI ≥ 90	70
Omnidirectional Lamp w/ CRI < 90	80
Directional Lamp w/ CRI ≥ 90	61
Directional Lamp w/ CRI < 90	70
Non-Directional Luminaire	65
Cove or Under Cabinet Mount Directional Luminaire	50
Outdoor, Wall-, Porch-, Pendant-, Post-Mounted and Security Luminaires	60
Accent Lights (including Track Light Luminaires & Line Voltage Track Heads)	55
Portable Desk Task Light	50
Inseparable Other SSL Luminaire	70

ENERGY STAR has sunset specifications for lamps and luminaires, while downlight fixtures and retrofit kits are covered by a new standard.[39] Compliance for downlight products shall align with the effective version of the ENERGY STAR Program Requirements for Downlights.

Operating Hours

Look up operating hours from the table below, based on lamp location and city. See details below for derivation of operating hours. "Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting. "Unknown" is not a valid selection for direct install programs.

City	Interior	Exterior	Unknown
Albany	999	2,273	1,125
Binghamton	999	2,273	1,125
Buffalo	999	2,273	1,125
Massena	999	2,273	1,125
NYC	1,752	1,606	1,752
Poughkeepsie	999	2,273	1,125
Syracuse	999	2,273	1,125

NYS cities other than NYC, Interior

Hours of operation for NYS cities other than NYC are taken from an Impact and Process Evaluation Study.[40]

[39] ENERGY STAR Program Requirements for Downlights - Eligibility Criteria Version 1.0, April 2024.
[40] NMR Group Inc., "ONLINE MARKETPLACE & ELECTRIC RESIDENTIAL CONSUMER PRODUCTS, Impact and Process Evaluation", June 9, 2023. Table 4-16. Modeled HOU compared to HOU listed in TRMs.

NYC, Interior
Hours of operation for exterior lighting is estimated to be 4.8 operating hours per day or 1,752 (4.8 x 365) hours per year. This value is derived from on-site lighting inventories of homes in New York City and Westchester County.[41]

NYC, Exterior
Hours of operation for exterior lighting is estimated to be 4.4 operating hours per day or 1,606 (4.4 x 365) hours per year. This value is derived from on-site lighting inventories of homes in New York City and Westchester County.[42]

NYC, Unknown
Hours of operation for lighting installed in an unknown location is estimated to be 4.8 operating hours per day or 1,752 (4.8 x 365) hours per year. This value is a weighted average of interior and exterior lighting hours derived from on-site lighting inventories of homes in New York City and Westchester County.[43]

LMI LED Table of Hours per Day by Unit Count
The hours per day values prescribed in the table below are intended for use with the Alternate Method for Calculating Annual Energy Savings for LMI Projects established above for General Purpose LEDs. The values in this table are based on the observation that program participants tend to prioritize replacement of the most used bulbs first and, as additional bulbs are replaced, the average hours of use per bulb decreases. For this reason, the hours per day applied to a project replacing 1 -2 bulbs shall be 3.2, while a project replacing 3 – 5 bulbs shall use an hours per day value of 3 and so on.

The values established below reflect the findings and guidance presented in the DOE Residential End-Use Lighting Study, which found average daily hours of use for all residential lamps to be 1.6 nationally and in NY state.[44] These values are consistent with those applied in the EmPower New York program and are subject to change pending future program evaluations.

# of Bulbs	Hours/day (Rest of NY)	Hours/day (NYC)[45]
1 - 2	3.2	5.6
3 - 5	3.0	5.3
6 - 7	2.5	4.4

[41] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table ES-6: HOU by Area Adjusted for Snapback and Table 3-2: Sample Sizes, Overall HOU Estimates by Area and Room. HOU referenced is a weighted average for interior room types for DNY and is Snapback Adjusted.
[42] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table ES-6: HOU by Area Adjusted for Snapback. HOU referenced is the value for Exterior for DNY and is Snapback Adjusted.
[43] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table ES-6: HOU by Area Adjusted for Snapback. HOU referenced is the value for Household for DNY, which is a weighted average of all room types and is Snapback Adjusted. The study's sample size included far more interior to exterior lights, thus a weighted distribution heavily favors the interior lighting hours.
[44] DOE Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates, December 2012; Table 4.1
[45] Hours/Day values in this table reflect a direct linear ratio of the values in the market rate HOU table above for NYC compared to other NY locations (i.e., NYC HOU are adjusted by a factor of 1,752/999 = 1.78).

8 - 9	1.5	2.6
10 - 16	1.0	1.8

Example Calculation *(Not to be used as default)*

A residential LMI customer replaces ten 60-watt incandescent lamps with 10-watt LED lamps throughout the interior of their home located near Albany. The home has a central AC and gas-furnace. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_{ff}$$

units = 10, from application
$W_{baseline}$ = 60, from application
W_{ee} = 10, from application
hrs = 999, from Operating Hours section table based on lamp location and city from application
$HVAC_c$ = 0.043, from Appendix D based on building type, HVAC type, and location from application
$HVAC_d$ = 0.073, from Appendix D based on building type, HVAC type, and location from application
CF = 0.16, from Summary of Variables and Data Sources table based on lamp location from application
$HVAC_{ff}$ = -0.003, from Appendix D based on building type, HVAC type, and location from application

$$\Delta kWh = 10 \times \frac{(60 - 10)}{1{,}000} \times 999 \times (1 + 0.043) = 521\ kWh$$

$$\Delta kW = 10 \times \frac{(60 - 10)}{1{,}000} \times (1 + 0.073) \times 0.16 = 0.09\ kW$$

$$\Delta MMBtu = 10 \times \frac{(60 - 10)}{1{,}000} \times 999 \times (-0.003) = -1.50\ MMBtu$$

Alternate Method for Calculating Annual Energy Savings for LMI Projects

General Purpose LEDs

$$\Delta kWh = units\ \times \left(\frac{\Delta W_{LMI,GP} \times 365}{1{,}000}\right) \times hrs$$

units = 10, from application
$\Delta W_{LMI,GP}$ = 46, from application
hrs = 1, from Operating Hours section, LMI LED Table of Hours per Day by Unit Count

$$\Delta kWh = 10\ \times \left(\frac{46 \times 365}{1{,}000}\right) \times 1 = 168\ kWh$$

Effective Useful Life (EUL)

For Downstream Market Rate applications, see Appendix P.

For LMI applications relying on existing conditions to serve as baseline, and for the alternative method presented for LMI applications, use 3.3 years.[46]

For Midstream and Upstream applications relying on a blended baseline, use 10.7 years.[47]

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

[46] The EUL is established based on the expected ratio of lifetime savings to annual savings. Given an incandescent existing condition (with an assumed 1-year remaining useful life), installation of an LED with a 15-year lifetime and an efficacy ratio of 6:1 for LED vs. incandescent technology, the EUL is established as Lifetime Savings/Annual Savings = ((Annual Savings * 1 Year) + (Annual Savings * 1/6 * 14 Years)) / Annual Savings = 1 + 14/6 = 3.3.
[47] Midstream and Upstream methods use the same approach, but apply a blended weighting, in alignment with the blended baseline weighting. Applying the same weighting as used to establish blended baselines for Midstream and Upstream applications (37% LMI and 63% Market Rate) to assumed downstream market rate and LMI application lifetimes (15 years and 3.3 years, respectively).

References

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    Available from: https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf
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HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) – CONTROL

OUTDOOR TEMPERATURE SETBACK CONTROL FOR HYDRONIC BOILER

Measure Description

This measure covers the installation of outdoor temperature setback control for single and multi-family residential fossil fuel-fired boilers. The outdoor temperature setback control uses two temperature sensors – one outside the home and one in the boiler water. It adjusts the hot water setpoint temperature of the boiler in response to outdoor air temperature. During milder seasons like fall and spring, the water can be set to a cooler temperature, while it is heated more during the coldest winter months. As the outdoor temperature fluctuates, the control adjusts the water temperature to the lowest level that still meets heating needs, with built-in safeguards to prevent the boiler from operating outside its safe range.

This measure is only applicable to retrofit of existing boiler systems. One outdoor temperature setback control measure may be applied to each boiler.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Summer Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = \frac{kBTU/h_{in}}{1{,}000} \times EFLH_{heating} \times ESF$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
$kBTU/h_{in}$	= Fuel input rating (kBTU/h)
$EFLH_{heating}$	= Heating equivalent full-load hours
ESF	= Energy savings factor
1,000	= Conversion factor, one MMBtu equals 1,000 kBTU

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTU/h_{in}$		From application.
$EFLH_{heating}$		Look up based on building type, vintage, and location in

Variable	Value	Notes
		Appendix G.
ESF	0.05	Cadmus Group, Inc.[48]

Coincidence Factor (CF)

The prescribed value for the coincidence factor is N/A.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is an existing single or multi-family residential boiler without outdoor temperature setback control.

For LMI applications, existing condition baseline shall be established based on nameplate efficiency or efficiency measured through combustion analysis.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an existing single or multi-family residential boiler equipped with outdoor temperature setback control.

Operating Hours

Heating equivalent full-load hours were calculated from a DOE-2.2 simulation of prototypical single and multi-family residential buildings. Operating hour assumptions for the prototypical building models are described in Appendix A. The heating EFLH for residential buildings in NY are shown in Appendix G.

Example Calculation *(Not to be used as default)*

Outdoor temperature setback control is installed on a 150 kBTU/h boiler in a single-family, detached home located near Albany constructed in 1995. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are not applicable. Annual Fossil Fuel Energy Savings are calculated as below.

$$\Delta MMBtu = \frac{kBTU/h_{in}}{1{,}000} \times EFLH_{heating} \times ESF$$

$kBTU/h_{in}$ = 150, from application
$EFLH_{heating}$ = 933, from Appendix G based on housing type, building vintage, and location from application
ESF = 0.05, from Summary of Variables and Data Sources table

$$\Delta MMBtu = \frac{150}{1{,}000} \times 933 \times 0.05 = 7\ MMBtu$$

[48] Cadmus Group, Inc., Home Energy Services Impact Evaluation, August 2012, pg. 20.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Lower boiler set point temperatures may cause hot water circulators to run longer cycles. This impact is anticipated to be minor and is not quantified in this measure.

References

1. Cadmus Group, Inc., Home Energy Services Impact Evaluation, August 2012. Available from: https://ma-eeac.org/wp-content/uploads/Home-Energy-Services-Impact-Evaluation-Report_Part-of-the-Massachusetts-2011-Residential-Retrofit-and-Low-Income-Program-Area-Evaluation.pdf

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

REFRIGERANT CHARGE CORRECTION & TUNE UP – AIR CONDITIONER AND HEAT PUMP

Measure Description

This measure estimates savings associated with refrigerant charge correction for unitary and split system air conditioners and heat pumps in single and multi-family residential applications. In order to be eligible for energy savings, the scope of work performed must include manufacturer recommended AC tune-up procedures including but not limited to the cleaning of the condenser coils.

The algorithms below represent first year savings. To formulate lifetime energy impacts and other benefits, savings shall be derated year-over-year at the rate of 1/EUL for the lifetime of the measure.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

For Units with Cooling Capacity < 65,000 BTU/h

$$\Delta kWh = units \times \left\{ \left[tons/unit \times \left(\frac{12}{SEER_{baseline}} - \frac{12}{SEER_{ee}} \right) \times EFLH_{cooling} \right] + \left[(kBTU/h)_{out}/unit \times \left(\frac{1}{HSPF_{baseline}} - \frac{1}{HSPF_{ee}} \right) \times EFLH_{heating} \right] \right\}$$

For Units with Cooling Capacity ≥ 65,000 BTU/h

$$\Delta kWh = units \times \left\{ \left[tons/unit \times \left(\frac{12}{IEER_{baseline}} - \frac{12}{IEER_{ee}} \right) \times EFLH_{cooling} \right] + \left[\frac{(kBTU/h)_{out}/unit}{3.412} \times \left(\frac{1}{COP_{baseline}} - \frac{1}{COP_{ee}} \right) \times EFLH_{heating} \right] \right\}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times tons/unit \times \left(\frac{12}{EER_{baseline}} - \frac{12}{EER_{ee}} \right) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings

ΔMMBtu = Annual fossil fuel energy savings
units = Number of measures installed under the program
tons/unit = Tons of air conditioning per unit, based on AHRI certification or nameplate data of condenser or matched pair (condenser and coil)
$(kBTU/h)_{out}$/unit = Output heating capacity in kBTU/h (at AHRI standard high-temperature rating conditions)
baseline = Characteristic of baseline condition
ee = Characteristic of energy efficient condition
SEER = Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
IEER = Integrated energy efficiency ratio in BTU/watt-hour. A weighted calculation of mechanical cooling efficiencies at full load and part load AHRI standard rating conditions (used only for units with cooing capacity ≥ 65,000BTU/h)
EER = Energy efficiency ratio under peak conditions, measurement of cooling capacity for a unit (in BTU/h) / electrical energy used (watts) (at AHRI standard rating conditions)
HSPF = Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric strip heat) during the heating season divided by the total electric energy heat pump consumed in watt-hours
COP = Coefficient of performance, ratio of output energy/input energy (at AHRI standard high-temperature rating conditions)
$EFLH_{cooling}$ = Cooling equivalent full-load hours
$EFLH_{heating}$ = Heating equivalent full-load hours
CF = Coincidence factor
12 = (kBTU/h)/ton of air conditioning capacity
3.412 = Conversion factor, one watt-hour equals 3.412 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
tons/unit		From application.
$kBTU/h_{out}$		From application.
$SEER_{ee}$		Actual equipment nameplate SEER. For equipment rated in SEER2, SEER2 rating shall be used.
$SEER_{baseline}$		Actual equipment nameplate SEER, derated in accordance with the Baseline Efficiency section below. For equipment rated in SEER2, SEER2 rating shall be used.
$IEER_{ee}$		Actual equipment nameplate IEER.
$IEER_{baseline}$		Actual equipment nameplate IEER, derated in accordance with the Baseline Efficiency section below.
EER_{ee}		Actual equipment nameplate EER. For equipment rated in EER2, EER2 rating shall be used.
$EER_{baseline}$		Actual equipment nameplate EER, derated in accordance with the Baseline Efficiency section below. For equipment rated in EER2, EER2 rating shall be used.

Variable	Value	Notes
$HSPF_{ee}$		Actual equipment nameplate HSPF. For equipment rated in HSPF2, HSPF2 rating shall be used.
$HSPF_{baseline}$		Actual equipment nameplate HSPF, derated in accordance with the Baseline Efficiency section below. For equipment rated in HSPF2, HSPF2 rating shall be used.
COP_{ee}		Actual equipment nameplate COP.
$COP_{baseline}$		Actual equipment nameplate COP, derated in accordance with the Baseline Efficiency section below.
$EFLH_{cooling}$		Look up based on building type, vintage and location in Appendix G.
$EFLH_{heating}$		Look up based on building type, vintage and location in Appendix G.
CF	0.69	

Coincidence Factor (CF)

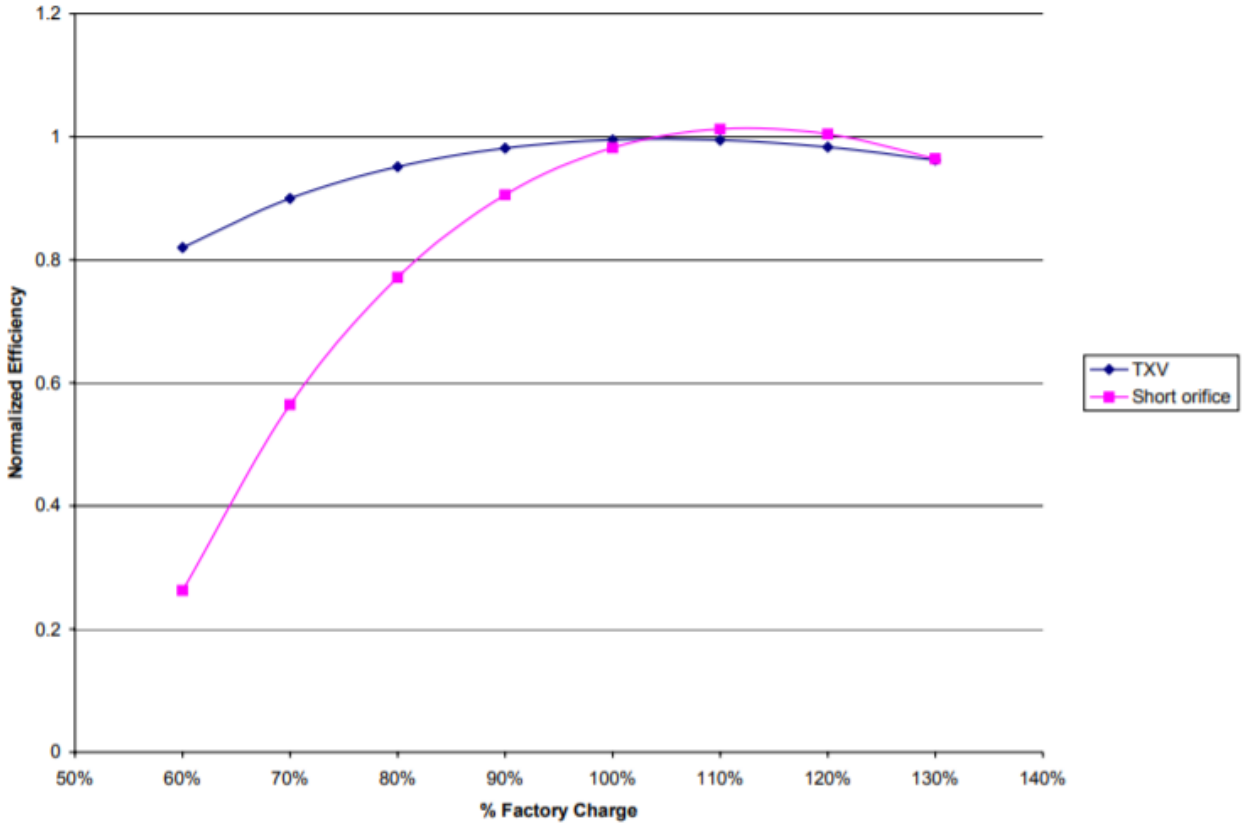
The prescribed value for the coincidence factor is 0.69.[49]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is equivalent to the existing condition with efficiency ratings taken from the actual equipment nameplate, derated to account for under or overcharging. The efficiency improvement resulting from refrigerant charge adjustment is dependent upon the discrepancy between the actual equipment charge before the adjustment was performed and the manufacturer's specification. The efficiency adjustment factor as a function of charge adjustment is taken from the figure or table below.[50] Note the efficiency change depends on the type of expansion valve. Use the curve or column labeled "TXV" for units with thermal expansion valves; otherwise use the curve or column labeled "Short orifice".

[49] 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 TRM Management Committee.

[50] Efficiency as a function of charge adjustment from Small HVAC System Design Guide, New Buildings Institute, 2003.



% Factory Charge	Normalized Efficiency (Short Orifice)	Normalized Efficiency (TXV)	% Factory Charge	Normalized Efficiency (Short Orifice)	Normalized Efficiency (TXV)
60%	0.26	0.82	96%	0.96	0.99
62%	0.32	0.84	98%	0.97	0.99
64%	0.39	0.85	100%	0.98	1.00
66%	0.45	0.87	102%	0.99	1.00
68%	0.51	0.89	104%	1.00	1.00
70%	0.56	0.90	106%	1.00	1.00
72%	0.61	0.91	108%	1.00	1.00
74%	0.66	0.92	110%	1.00	1.00
76%	0.70	0.93	112%	1.00	0.99
78%	0.73	0.94	114%	1.00	0.99
80%	0.77	0.95	116%	1.00	0.99
82%	0.80	0.96	118%	1.00	0.99
84%	0.83	0.97	120%	1.00	0.99
86%	0.86	0.97	122%	1.00	0.98
88%	0.88	0.98	124%	0.99	0.98
90%	0.91	0.98	126%	0.98	0.97
92%	0.92	0.99	128%	0.97	0.97
94%	0.94	0.99	130%	0.96	0.96

If the equipment is a multi-circuit system, the overall efficiency adjustment shall be calculated as the sum of each circuit's derating factor multiplied by its percentage of the total system capacity. For example, the equation for $EER_{baseline}$ is shown below:

$$EER_{baseline} = EER_{ee} \times \sum_{n} \left(Cap_n \times F_{derate,n}\right)$$

where:

n	= Each circuit
Cap	= Fraction of total capacity
F_{derate}	= Derating factor, normalized efficiency from figure/table above

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a residential air-cooled unitary or split system air conditioner or heat pump that has undergone a tune up involving a refrigerant charge correction. SEER, IEER, EER, HSPF, and COP values are taken from application as reported on the equipment nameplate or manufacturer specifications.

Operating Hours

For central air conditioners and heat pumps, look up EFLH data by location, building type and vintage from Appendix G. The oversizing assumptions embedded in the Appendix G data are appropriate for equipment sized to meet the peak-cooling load for central air conditioners and air source heat pumps.

Example Calculation *(Not to be used as default)*

A split system 3-ton heat pump with 36 kBTU/h heating capacity undergoes refrigerant charge correction and tune-up per manufacture recommended procedures in a single-family, detached home located near Albany constructed in 1995. The heat pump is rated at 18 SEER, 13.7 EER, and 10 HSPF and is equipped with a thermal expansion valve. It was determined that the unit was operating at 70% of factory charge prior to correction. Annual Fossil Fuel Energy Savings are not applicable. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are calculated as below.

$$\Delta kWh = units \times \left\{\left[tons/unit \times \left(\frac{12}{SEER_{baseline}} - \frac{12}{SEER_{ee}}\right) \times EFLH_{cooling}\right] + \left[(kBTU/h)_{out}/unit \times \left(\frac{1}{HSPF_{baseline}} - \frac{1}{HSPF_{ee}}\right) \times EFLH_{heating}\right]\right\}$$

$$\Delta kW = units \times tons/unit \times \left(\frac{12}{EER_{baseline}} - \frac{12}{EER_{ee}}\right) \times CF$$

units = 1, from application
tons/unit = 3, from application

$F_{derate,n}$ = from Baseline Efficiencies table based on percentage of factory charge correction and expansion valve type from application
$SEER_{ee}$ = 18, from application
$SEER_{baseline}$ = $SEER_{ee}$ x $F_{detrate,n}$ = 18 x 0.9 = 16.2
$EFLH_{cooling}$ = 358, from Appendix G based on housing type, building vintage, and location from application.
$(kBTU/h)_{out}$/unit = 36, from application
$HSPF_{ee}$ = 10, from application
$HSPF_{baseline}$ = $HSPF_{ee}$ x $F_{detrate,n}$ = 10 x 0.9 = 9, from Baseline Efficiencies table based on percentage of factory charge correction and expansion valve type from application
$EFLH_{heating}$ = 933, from Appendix G based on housing type, building vintage, and location from application
EER_{ee} = 13.7, from application
$EER_{baseline}$ = EER_{ee} x $F_{detrate,n}$ = 13.7 x 0.9 = 12.3, from Baseline Efficiencies table based on percentage of factory charge correction and expansion valve type from application
CF = 0.69, from Summary of Variables and Data Sources table

$$\Delta kWh = 1 \times \left\{\left[3 \times \left(\frac{12}{16.2} - \frac{12}{18}\right) \times 358\right] + \left[36 \times \left(\frac{1}{9} - \frac{1}{10}\right) \times 933\right]\right\} = 453\ kWh$$

$$\Delta kW = 1 \times 3 \times \left(\frac{12}{12.3} - \frac{12}{13.7}\right) \times 0.69 = 0.21\ kW$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. Small HVAC System Design Guide, New Buildings Institute, White Salmon, WA for the California Energy Commission.
   Available from: https://dl.icdst.org/pdfs/files/0d461bb519f578b1501491fcc47c8184.pdf
2. BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.

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OTHER

SHADE TREES

Measure Description

This measure covers the planting of trees nearby a single-family detached home in New York State. These trees provide primarily electric cooling savings by shading a home from sunlight, thereby reducing heat gain. Projects may also experience heating savings by partially blocking cold winds from hitting homes. However, these savings from wind shielding may be negated by reduced heat from solar energy, particularly in northern NY locations.

To claim energy savings, trees must be planted south, southwest, or west within 60 feet[51] of the home.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{\Delta \text{kWh}}{unit}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \left(\frac{\Delta \text{kWh}}{hrs_{cooling}}\right) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{\Delta \text{MMBtu}}{unit}$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
ΔMMBtu = Annual fossil fuel energy savings
units = Number of trees planted
ΔkWh/unit = Deemed annual electric energy savings per unit
ΔMMBtu/unit = Deemed annual fossil fuel energy savings per unit
$hrs_{cooling}$ = System operating hours during the cooling season

Summary of Variables and Data Sources

Variable	Value	Notes
units		From application.

[51] 60-foot threshold based on maximum distance with nonzero savings when modeled in -Tree Planting Calculator.

Variable	Value	Notes
ΔkWh/unit		Look up in Deemed Savings Table section below based on location.
ΔMMBtu/unit		Look up in Deemed Savings Table section below based on location.

Coincidence Factor (CF)

The prescriptive value for the coincidence factor is presented in the table below, based on the equipment type.

Equipment Type	CF Value
Central Air Conditioner	0.69[52]
Room Air Conditioner	0.3[53]

Baseline Efficiencies from which Savings are Calculated

The baseline condition for this measure is a single family detached home with no trees planted south, southwest, or west within 60 feet of the home.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is that 1 to 3 shade trees must be planted no closer than 20 feet apart and located in the south, southwest, or west within 60 feet of a single-family detached home.

Trees must have a minimum lifespan of 20 years. They should provide shade to at least the third story of a home during the cooling season, requiring them to reach a height of at least 30 feet when fully mature.

Deemed Savings Table

Look up energy savings per unit from the table below, based on city. The kWh savings are associated with trees providing shade during the cooling season, while the MMBtu savings reflect the net impact of shading and shielding from cold winds during the heating season.

City	ΔkWh/unit	ΔMMBtu/unit	Net ΔMMBtu/unit[54]
Albany	38.2	-0.06	0.07
Binghamton	41.4	-0.06	0.09
Buffalo	41.4	-0.06	0.09
Massena	38.2	-0.06	0.07
NYC	75.7	0.16	0.42
Poughkeepsie	54.0	0.03	0.21

[52] Ibid.
[53] RLW Analytics, Coincidence Factor Study: Residential Room Air Conditioners, June 2008, p. iv (based on average Seasonal CF for all load zones using 2007 weather data).
[54] Estimated Shade Tree Savings with i-Tree Planting Calculator.

City	ΔkWh/unit	ΔMMBtu/unit	Net ΔMMBtu/unit[54]
Syracuse	43.0	-0.05	0.09

Effective Useful Life (EUL)

See Appendix P. (EUL to be 40 years).

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. i-Tree Planting Calculator, used to calculate energy savings and the value of environmental non-energy impacts across all New York State weather cities.
   Available from: https://planting.itreetools.org
2. Weather city map assembled using ArcGIS and NYSERDA weather city zip codes, with nine points picked out for each weather city zone to average into deemed savings values. Map and calculation sheet available on DMM under Case (TBD).
3. Communication with a representative of the Arbor Day Foundation indicating that oak trees are the most popular tree planted by shade tree program participants. Oak trees were the species used in the deemed savings development. E-mail communication available on DMM under Case (TBD).
4. BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.
5. RLW Analytics, Coincidence Factor Study: Residential Room Air Conditioners, June 2008.
   Available from: https://library.cee1.org/system/files/library/8791/CEE_Eval_FinalReportCoincidenceFactorStudyResidentialRoomAirConditioners2008_23Jun2008.pdf

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

TUNE-UP - BOILER

Measure Description

This measure covers tune-up of residential fossil fuel-fired space heating boilers to improve seasonal heating efficiency. A tune-up involves the inspection, cleaning, and/or adjustment of boiler and appurtenances per manufacturer's recommendations. This measure addresses tune-up benefits associated with heating performance in single - family or low-rise multifamily buildings only. For boiler tune-up in high-rise multifamily buildings, see Commercial Boiler Tune-Up measure.

The algorithms below represent first year savings. To formulate lifetime energy impacts and other benefits, savings shall be derated year-over-year at the rate of 1/EUL for the lifetime of the measure.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Summer Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{kBTU/h_{in}/unit}{1{,}000} \times EFLH_{heating} \times ESF$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
$kBTU/h_{in}$	= Nameplate capacity fuel input rating (kBTU/h) per boiler
$EFLH_{heating}$	= Heating equivalent full-load hours
ESF	= Energy savings factor
1,000	= Conversion factor, one MMBtu equals 1,000 kBTU

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTU/h_{in}$/unit		From application.
$EFLH_{heating}$		Look up based on building type, vintage and location in Appendix G.

Variable	Value	Notes
ESF	0.04	The energy savings factor for boiler tune-ups is used to estimate the annual heating energy savings.[55]

Coincidence Factor (CF)

The prescribed value for the coincidence factor is N/A.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a residential fossil fuel-fired space heating boiler in a single-family or low-rise multifamily building that has not received a tune-up in 5 years or more. Because savings are established as a percent savings relative to the existing condition, there is no distinction in the approach for baseline determination between market-rate and LMI applications.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a residential fossil fuel-fired boiler that has undergone a tune-up in accordance with the manufacturer's recommendations.

Operating Hours

Heating equivalent full-load hours were calculated from a DOE-2.2 simulation of prototypical single and multi-family residential buildings. Operating hour assumptions for the prototypical building models are described in Appendix A. The heating EFLH for residential buildings in NY are shown in Appendix G.

Example Calculation *(Not to be used as default)*

A 150 kBTU/h boiler undergoes a maintenance tune-up in a single-family, detached home located near Albany constructed in 1995. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are not applicable. Annual Fossil Fuel Energy Savings are calculated as below.

$$\Delta MMBtu = units \times \frac{kBTU/h_{in}/unit}{1{,}000} \times EFLH_{heating} \times ESF$$

units = 1, from Summary of Variables and Data Sources table
$kBTU/h_{in}/unit$ = 150, from application
$EFLH_{heating}$ = 933, from Appendix G based on housing type, building vintage, and location from application
ESF = 0.04, from Summary of Variables and Data Sources table

$$\Delta MMBtu = 1 \times \frac{150}{1{,}000} \times 933 \times 0.04 = 5.60\ MMBtu$$

[55] Boiler tune-up results in average energy savings of 4 – 5%, per CSE Magazine, "Cost-effective boiler system retrofits", February 2010

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Improved boiler efficiency as a result of a boiler tune-up will reduce the run time of the distribution system's circulator pumps and boiler combustion fan if so equipped. These effects are anticipated to be small and are not currently quantified for this measure.

References

1. Mary Sue Lobenstein and Martha J. Hewett, M.S., Center for Energy and Environment, Minneapolis, and John T. Katrakis, PE, LEED AP, J.T. Katrakis & Assocs. Inc., Barrington, Ill., "Cost-effective boiler system retrofits", February 2010
   Available from: https://www.csemag.com/articles/cost-effective-boiler-system-retrofits/

Record of Revision

Record of Revision Number	Issue Date
6-18-15	6/26/2018
9-24-7	10/22/2024

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AGRICULTURAL EQUIPMENT

HIGH-SPEED FAN

Measure Description

This measure is applicable to the installation of high-speed and high efficiency fans installed in agricultural applications. For the purposes of this measure, a high-speed fan shall consist of the blade and motor assembly. Air circulating, ventilation, and exhaust 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.[56]

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{\left[\left(\frac{CFM_{baseline}}{\left(\frac{CFM}{W}\right)_{baseline}}\right) - \left(\frac{CFM_{ee}}{\left(\frac{CFM}{W}\right)_{ee}} \times F_{VFD,ee}\right)\right]}{1{,}000} \times hrs$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{\Delta kWh}{hrs} \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of fans installed under the program
baseline	= Characteristic of baseline condition
ee	= Characteristic of energy efficient condition
CFM	= Air flow, measured in cubic feet per minute

[56] AMCA International's Certified Ratings Program (CRP): https://www.amca.org/certify/

CFM/W = Fan efficiency rating, in CFM/W
$F_{VFD,ee}$ = Factor to account for reduced consumption resultant from VFD control
hrs = Annual hours of operation
CF = Coincidence Factor
1,000 = Conversion factor, one kW equals 1,000 Watts

Summary of Variables and Data Sources

Variable	Value	Notes
$CFM_{baseline}$		From application, as seen on nameplate. If unknown, or for new installations, use CFM_{ee} as the default value.
CFM_{ee}		From application.
$(CFM/W)_{baseline}$		From application, as seen on nameplate. If not available, look up from Baseline Efficiencies section below based on fan diameter. If $(CFM/W)_{ee}$ is rated at a specified static pressure (i.e., for ventilation and exhaust fans), the $(CFM/W)_{baseline}$ value selected from the Baseline Efficiencies section below shall reflect the same static pressure.
$(CFM/W)_{ee}$		From application, as specified in manufacturer cut sheets based on AMCA-accredited lab testing.
$F_{VFD,ee}$	No VFD: 1.00 VFD (Indoor Grow Facility): 0.64 VFD (Poultry/Livestock): 0.75	Adjustment to efficient condition consumption to account for VFD control, based on presence of VFDs and fan application.[57]
hrs		From application. If unavailable, lookup in Operating Hours section below.
CF	1.0	

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is 1.0.[58]

[57] 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.
[58] It is assumed that fans will always be running during the peak hour.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition for this measure is a standard efficiency air circulating, ventilation, or exhaust fan. Baseline fan airflow and fan efficiency (CFM/W) shall come from application. If unavailable, look up from the table below based on fan type, diameter, and for ventilation and exhaust fans, static pressure aligned with rated CFM/W of the efficient case.[59]

Fan Diameter	Air Circulating Fans	Ventilation and Exhaust Fans	
	(CFM/W)	(CFM/W) (0.05"SP)	(CFM/W) (0.10"SP)
8" – 23"	8.4	8.7	8.2
24" – 35"	10.8	10.0	9.4
36" – 47"	14.4	12.7	11.8
48"+	18.2	16.9	15.2

Compliance Efficiency from which Incentives are Calculated

The compliance condition for this measure is a high-speed air circulating, ventilation, or exhaust fan rated by an Air Movement and Control Association (AMCA) accredited laboratory in accordance with all AMCA testing standards that meets or exceeds the minimum efficiency requirements from the table below, based on fan type, diameter, and for ventilation and exhaust fans, static pressure.[60]

Fan Diameter	Air Circulating Fans	Ventilation and Exhaust Fans	
	(CFM/W)	(CFM/W) (0.05"SP)	(CFM/W) (0.10"SP)
8" – 23"	13.1	11.9	11.0
24" – 35"	15.0	14.8	11.0
36" – 47"	20.9	19.2	16.9
48"+	24.5	23.4	20.7

Operating Hours

Fan operating hours shall come from application. If operating hours are unknown, the prescribed hours shall come from the lookup table below based on location. Default hours are developed from NOAA hourly normals by summing annual hours dry bulb temperature is above 50ºF.[61]

[59] 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 expected to be more efficient than the average market available fan and application of 10th percentile efficiencies are anticipated to represent a conservative baseline counterfactual. Ventilation and exhaust fan CFM and air 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.

[60] 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 different voltages.

[61] NOAA National Centers for Environmental information – NCEI 1991 - 2020 Hourly Normals.

City	Air Circulating Fan Hours	Exhaust/Ventilation Fan Hours[62]
Albany	4,308	6,570
Binghamton	3,983	6,570
Buffalo	4,203	6,570
Massena	3,896	6,570
NYC	4,988	6,570
Poughkeepsie	4,440	6,570
Syracuse	4,236	6,570

Example Calculation *(Not to be used as default)*

A poultry farm near Poughkeepsie, NY replaces two 30-inch air circulating fans rated at 2,500 CFM and 15 CFM/W with high-speed fans rated at 2,000 CFM and 20 CFM/W equipped with VFD control. The fans run for 4,300 hours per year. Annual Fossil Fuel Energy Savings are not applicable. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are calculated as below.

$$\Delta kWh = units \times \frac{\left[\left(\frac{CFM_{baseline}}{\left(\frac{CFM}{W}\right)_{baseline}}\right) - \left(\frac{CFM_{ee}}{\left(\frac{CFM}{W}\right)_{ee}} \times F_{VFD,ee}\right)\right]}{1{,}000} \times hrs$$

$$\Delta kW = \frac{\Delta kWh}{hrs} \times CF$$

units = 2, from application
$CFM_{baseline}$ = 2,500 CFM, from application
$(CFM/W)_{baseline}$ = 15 CFM/W, from application
CFM_{ee} = 2,000 CFM, from application
$(CFM/W)_{ee}$ = 20 CFM/W, from application
$F_{VFD,ee}$ = 0.75, from Summary of Variables and Data sources table
CF = 1, from Summary of Variables and Data sources table
hrs = 4,300 hours, from application

$$\Delta kWh = 2 \times \frac{\left[\left(\frac{2{,}500}{15}\right) - \left(\frac{2{,}000}{20} \times 0.75\right)\right]}{1{,}000} \times 4{,}300 = 788.33\ kWh$$

$$\Delta kW = \frac{788}{4{,}300} \times 1 = 0.18\ kW$$

[62] Exhaust/Ventilation fans are assumed to operate 75% of total annual hours (8,760 x 0.75 = 6,570).

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. 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.
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2. Agricultural Ventilation Fans, Bioenvironmental and Structural Systems Laboratory, University of Illinois, Department of Agricultural and Biological Engineering, Accessed September 26, 2019.
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3-20-3	3/30/2020
7-21-12	8/30/2021
9-24-8	10/22/2024

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APPLIANCE

ICE MAKER

Measure 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.[63]

This measure covers ice making head, remote condensing, and self-contained air-cooled ice makers. Commercial ice machines are commonly used in grocery stores, hospitals, hotels, offices, restaurants and schools. 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.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times (kWh_{baseline} - kWh_{ee}) \times 365 \times Cycle \times (IHR/100)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{\Delta kWh}{8{,}760 \times Cycle} \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
baseline	= Characteristic of baseline condition
ee	= Characteristic of energy efficient condition
kWh	= Daily electric energy consumption per 100 pounds of ice
Cycle	= Compressor duty cycle

[63] ENERGY STAR® Ice Machine Key Product Criteria.

IHR = Rated Ice Harvest Rate (lbs/day) of the energy efficient ice maker
CF = Coincidence factor
365 = Days in one year
100 = Factor to convert IHR to units of 100 lbs/day
8,760 = Hours in one year

Summary of Variables and Data Sources

Variable	Value	Notes
$kWh_{baseline}$		Look up based on efficient Equipment Type and Ice Harvest Rate from Baseline Efficiency section below.
kWh_{ee}		From application. If unknown, look up based on efficient Equipment Type and Ice Harvest Rate from Compliance Efficiencies section below.
IHR		Rated capacity of efficient ice maker from application.
Cycle	0.57	Compressor duty cycle.[64]
CF	0.9	

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.9.[65]

Baseline Efficiencies from which Energy Savings are Calculated

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[66] and continuous type[67] ice makers, as specified in the Code of Federal Regulations and provided in the table below.

Equipment Type	Ice Harvest Rate (IHR)	Maximum Daily Energy Use per 100 lbs ($kWh_{baseline}$)
Batch Type, Ice-Making Head	< 300	10 - 0.01233 x IHR
Batch Type, Ice-Making Head	≥ 300 and < 800	7.05 - 0.0025 x IHR
Batch Type, Ice-Making Head	≥ 800 and < 1,500	5.55 - 0.00063 x IHR
Batch Type, Ice-Making Head	≥ 1500 and < 4,000	4.61
Batch Type, Remote Condensing	< 988	7.97 - 0.00342 x IHR
Batch Type, Remote Condensing	≥ 988 and < 4,000	4.59
Batch Type, Self-Contained	< 110	14.79 - 0.0469 x IHR

[64] Food Service Technology Center, A Field Study to Characterize Water and Energy Use of Commercial Ice Machines and Quantify Saving Potential, June 2007: Average of metered average duty cycle of eight in-situ commercial ice machines
[65] PG&E Work Paper SWFS006-03, pg. 17.
[66] 10 CFR 431.136 (c).
[67] 10 CFR 431.136 (d).

Equipment Type	Ice Harvest Rate (IHR)	Maximum Daily Energy Use per 100 lbs ($kWh_{baseline}$)
Batch Type, Self-Contained	≥ 110 and < 200	12.42 - 0.02533 x IHR
Batch Type, Self-Contained	≥ 200 and < 4,000	7.35
Continuous Type, Ice-Making Head	< 310	9.19 - 0.00629 x IHR
Continuous Type, Ice-Making Head	≥ 310 and < 820	8.23 - 0.0032 x IHR
Continuous Type, Ice-Making Head	≥ 820 and < 4,000	5.61
Continuous Type, Remote Condensing	< 800	9.7 - 0.0058 x IHR
Continuous Type, Remote Condensing	≥ 800 and < 4,000	5.06
Continuous Type, Self-Contained	< 200	14.22 - 0.03 x IHR
Continuous Type, Self-Contained	≥ 200 and < 700	9.47 - 0.00624 x IHR
Continuous Type, Self-Contained	≥ 700 and < 4,000	5.1

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an ENERGY STAR® 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® maximum qualifying specifications, as shown in the table below.[68]

Equipment Type	Ice Harvest Rate (IHR)	Maximum Daily Energy Use per 100 lbs (kWh_{ee})	Potable Water Use (gal/100 lbs ice)
Batch Type, Ice-Making Head	< 300	9.20 - 0.01134 x IHR	≤ 20.0
Batch Type, Ice-Making Head	≥ 300 and < 800	6.49 - 0.0023 x IHR	≤ 20.0
Batch Type, Ice-Making Head	≥ 800 and < 1,500	5.11 - 0.00058 x IHR	≤ 20.0
Batch Type, Ice-Making Head	≥ 1500 and < 4,000	4.24	≤ 20.0
Batch Type, Remote Condensing	< 988	7.17 - 0.00308 x IHR	≤ 20.0
Batch Type, Remote Condensing	≥ 988 and < 4,000	4.13	≤ 20.0
Batch Type, Self-Contained	< 110	12.57 - 0.0399 x IHR	≤ 25.0
Batch Type, Self-Contained	≥ 110 and < 200	10.56 - 0.0215 x IHR	≤ 25.0
Batch Type, Self-Contained	≥ 200 and < 4,000	6.25	≤ 25.0
Continuous Type, Ice-Making Head	< 310	7.90 - 0.005409 x IHR	≤ 15.0

[68] ENEGY STAR® Program Requirements Product Specification for Automatic Commercial Ice Makers, Eligibility Criteria Version 3.0, January 2018.

Equipment Type	Ice Harvest Rate (IHR)	Maximum Daily Energy Use per 100 lbs (kWh_{ee})	Potable Water Use (gal/100 lbs ice)
Continuous Type, Ice-Making Head	≥ 310 and < 820	7.08 - 0.002752 x IHR	≤ 15.0
Continuous Type, Ice-Making Head	≥ 820 and < 4,000	4.82	≤ 15.0
Continuous Type, Remote Condensing	< 800	7.76 - 0.00464 x IHR	≤ 15.0
Continuous Type, Remote Condensing	≥ 800 and < 4,000	4.05	≤ 15.0
Continuous Type, Self-Contained	< 200	12.37 - 0.0261 x IHR	≤ 15.0
Continuous Type, Self-Contained	≥ 200 and < 700	8.24 - 0.005429 x IHR	≤ 15.0
Continuous Type, Self-Contained	≥ 700 and < 4,000	4.44	≤ 15.0

Operating Hours

Commercial ice makers are assumed to be available for operation 24 hours per day, 365 days per year with a compressor duty cycle of 0.57.[69]

Example Calculation *(Not to be used as default)*

An ENERGY STAR® qualified continuous-type ice making head ice machine with ice harvest rate of 500 lb/day is installed in a hotel in NYC. Annual Fossil Fuel Energy Savings are not applicable. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are calculated as below.

$$\Delta kWh = units \times (kWh_{baseline} - kWh_{ee}) \times 365 \times Cycle \times (IHR/100)$$

$$\Delta kW = \frac{\Delta kWh}{8{,}760 \times Cycle} \times CF$$

units = 1, from application

$kWh_{baseline}$ = 8.23 – 0.0032 x IHR = 8.32 – 0.0032 x 500 = 6.72 kWh

$kWh_{baseline}$ equation based on Maximum Daily Energy use per 100lbs based on baseline equipment type

IHR = 500, from application

kWh_{ee} = 7.08 – 0.002752 x IHR =7.08 – 0.002752 x 500 = 5.704 kWh

kWh_{ee} equation based on Maximum Daily Energy use per 100lbs based on ENERGY

[69] Food Service Technology Center, A Field Study to Characterize Water and Energy Use of Commercial Ice Machines and Quantify Saving Potential, June 2007: Average of metered average duty cycle of eight in-situ commercial ice machines

STAR® qualified equipment type
IHR = 500, from application
Cycle = 0.57, from Summary of Variables and Data Sources
IHR = 500, from application
CF = 0.9, from Summary of Variables and Data Sources

$$\Delta kWh = 1 \times (6.73 - 5.704) \times 365 \times 0.57 \times \left(\frac{500}{100}\right) = 1{,}067.30\ kWh$$

$$\Delta kW = \frac{1{,}067.30}{8{,}760 \times 0.57} \times 0.9 = 0.19\ kW$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Efficient ice makers reject less heat than standard equipment, increasing space heating requirements while decreasing cooling load, when located inside a conditioned area. However, this interactivity is considered negligible for the installation of an air-cooled ice maker and is not included in the energy savings calculation.

Ancillary Electric Savings Impacts

Efficient ice makers reject less heat than standard equipment, increasing space heating requirements while decreasing cooling load, when located inside a conditioned area. However, this interactivity is considered negligible for the installation of an air-cooled ice maker and is not included in the energy savings calculation.

References

1. ENERGY STAR® Program Requirements Product Specification for Automatic Commercial Ice Makers Eligibility Criteria Version 3.0, January 2018.
   Available from: https://www.energystar.gov/sites/default/files/asset/document/Final%20V3.0%20ACIM%20Specification%205-17-17_1_1.pdf
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5. 10 CFR 431.136 Energy conservation standards and their effective dates.
   Available from: https://www.ecfr.gov/current/title-10/section-431.136

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6-18-19	6/26/2018
9-24-9	10/22/2024

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LIGHTING

INTERIOR AND EXTERIOR LIGHTING

Measure Description

This section covers energy-efficient lighting equipment, which consumes less energy to perform the same function and provide equal illuminance as conventional lighting equipment. Non-energy benefits such as improved health and productivity, reduction in environmental impacts, and improved lighting quality may also be achieved. Improved lighting fixtures may include reflectors and other optical improvements to lighting fixtures. These technologies, taken separately or combined into an energy-efficient lighting fixture, provide the required illumination at reduced input power.

Project-level lighting savings shall be treated as the summation of each unique baseline and efficient case retrofit. Different fixtures would need to be addressed by unique iterations of algorithms for non-LPD approach.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \left[\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right] \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \left[\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right] \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = \left[\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right] \times hrs \times HVAC_{ff}$$

New construction, space renovations or remodels may require a building permit that includes compliance with local or state energy codes. In these instances, the applicable energy code defines the baseline. The energy consumption of the efficient and baseline lighting systems are defined in terms of the lighting power density (LPD) in watts per square foot. An alternate form of the lighting equations based on LPD is as follows:

Annual Electric Energy Savings

$$\Delta kWh = SF \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = SF \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = SF \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times hrs \times HVAC_{ff}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
baseline	= Characteristic of baseline condition
ee	= Characteristic of energy efficient condition
SF	= Extent of space or surface illuminated by lighting system (in ft^2)
LPD	= Lighting power density
W	= Rated wattage of lamp or fixture (Watts)
hrs	= Lighting operating hours
$HVAC_c$	= HVAC interaction factor for annual electric energy consumption
$HVAC_d$	= HVAC interaction factor for utility summer peak hour
$HVAC_{ff}$	= HVAC interaction factor for annual fossil fuel consumption (MMBtu/kWh)
CF	= Coincidence factor
1,000	= Conversion factor, one kW equals 1,000 watts

Summary of Variables and Data Sources

Variable	Value	Notes
$units_{baseline}$		Number of baseline measures, from application. Set equal to $Units_{ee}$ if unknown.
$units_{ee}$		Number of energy efficient measures installed under the program, from application.
$W_{baseline}$		Connected load of the baseline unit(s) displaced, from application (in Watts).
W_{ee}		Connected load of the energy-efficient unit, from application (in Watts).
hrs		Lighting operating hours. From application or default, as listed below in the Operating Hours table.
$LPD_{baseline}$		Lighting power density (in W/SF) for baseline measure, from application, based on NYS/NYC Energy Conservation code. New construction or major renovation (as defined by applicable code/permits) only.

Variable	Value	Notes
LPD_{ee}		Lighting power density (in W/SF) for energy efficient measure, from application, based on installed system design. New construction or major renovation (as defined by applicable code/permits) only.
SF		Floor area illuminated by lighting system (in SF).
$HVAC_c$	Exterior and Unconditioned Space: 0	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	Exterior and Unconditioned Space: 0	HVAC interaction factor for peak demand at utility summer peak hour (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_{ff}$	Exterior and Unconditioned Space: 0	HVAC interaction factor for annual fossil fuel energy consumption (MMBtu/kWh). Vintage and HVAC type weighted average by city. See Appendix D.
CF	Interior: See Coincidence Factor (CF) section below Exterior: 0	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting. Lookup Interior CF based on facility type in Operating Hours section below.

HVAC system interaction factors are defined as the ratios of the cooling energy and demand reduction and heating energy increase per unit of lighting energy reduction. Much of the input energy for lighting systems is converted to heat that must be removed by the HVAC system. Reductions in lighting heat gains due to lighting power reduction decrease the need for space cooling and increase the need for space heating.

HVAC interaction factors vary by climate and HVAC system type. Prescribed values for HVAC interaction factors for lighting energy and peak demand savings are shown in Appendix D. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0.

Coincidence Factor (CF)

The prescribed coincidence factor for commercial exterior lighting is 0.0, since exterior lighting is generally off during daylight hours. Look up interior lighting CF from the table in the Operating Hours section below based on facility type.[70]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is assumed to be the existing and operational lighting fixture in all applications other than new construction or extensive renovations that trigger the building code. See table of standard fixture wattages in Appendix C. Note, depending on local codes, new construction, space renovations or remodels may require a building permit that includes compliance with local or state energy codes. In these instances, the applicable energy code defines the baseline.

[70] ConEd Large C&I Program Impact and Process Evaluation Report prepared by Navigant, August 2019, slide 71

Code LPD shall be taken from chapter C405.3: Interior Lighting Power Requirements (Prescriptive) and chapter C405.4: Exterior Lighting (Mandatory) of the Energy Conservation Construction Code of New York State[71] (ECCCNYS 2020) that are based on IECC 2018. Alternatively, ASHRAE Standard 90.1-2016 may be referenced for compliance. In both cases, either the Building Area or Space-By-Space compliance path may be used.

Compliance Efficiency from which Incentives are Calculated

The compliance condition for individual fixture/lamp replacement scenarios is an efficient lighting product (lamp or fixture) meeting the minimum requirements of the current effective version of Design Lights Consortium qualified products list or the minimum efficacy (lm/W) ratings based on Lamp / Fixture Type per the table below.[72]

Product categories/applications covered by DLC must meet all DLC qualified product technical specifications. Only products not covered by DLC shall be qualified based on minimum efficacy in provided table.

Lamp / Fixture Type	Minimum Efficacy (lm/W)
Omnidirectional Lamp w/ CRI ≥ 90	70
Omnidirectional Lamp w/ CRI < 90	80
Directional Lamp w/ CRI ≥ 90	61
Directional Lamp w/ CRI < 90	70
Non-Directional Luminaire	65
Cove or Under Cabinet Mount Directional Luminaire	50
Outdoor, Wall-, Porch-, Pendant-, Post-Mounted and Security Luminaires	60
Accent Lights (including Track Light Luminaires & Line Voltage Track Heads)	55
Portable Desk Task Light	50
Inseparable Other SSL Luminaire	70

ENERGY STAR has sunset specifications for lamps and luminaires, while downlight fixtures and retrofit kits are covered by a new standard.[73] Compliance for downlight products shall align with the effective version of the ENERGY STAR Program Requirements for Downlights.

See table of standard fixture wattages in Appendix C. Manufacturers' cut sheets may substitute for the standard fixture watts in Appendix C if available.

In new construction or major renovation projects, the new lighting system power consumption shall be expressed as a lighting power density (LPD) in watts per square foot. All equipment

[71] ECCCNYS 2020; C405.3: Interior Lighting Power Requirements (Prescriptive) & C405.4: Exterior Lighting Power (Mandatory).

[72] ENERGY STAR Program Requirements for Luminaires - Eligibility Criteria Version 2.2, August 15, 2019 & ENERGY STAR Program Requirements for Lamps - Eligibility Criteria Version 2.1, June 2, 2022

[73] ENERGY STAR Program Requirements for Downlights - Eligibility Criteria Version 1.0, April 2024.

installed under the LPD method shall comply with the minimum requirements above (i.e., DLC-compliant or meeting minimum efficacy from the table above) where such requirements are established. LPD methods shall be compliant with all applicable federal, state, local and municipal codes and standards.

Operating Hours

The average lighting operating hours are defined by building type, as shown in the table below. These are typical average values for the building types shown. Use building specific operating hours where available. For exterior lighting, the default annual operating hours are 4,380 hrs/yr (12 hours per day).

Facility Type	Lighting Hours (hrs/yr)	CF[74]	Facility Type	Lighting Hours (hrs/yr)	CF[75]
Auto Related*	2,810	0.89	Manufacturing Facility	2,857	0.67
Automotive / Transportation Service or Repair Facility (24/7)	8,760	0.89	Medical Offices	3,748	0.92
Bakery	2,854	0.79	Motion Picture Theatre	1,954	0.89
Banks	3,748	0.92	Multi-Family (Common Areas)	7,665	0.98
Church	1,955	0.89	Museum	3,748	0.89
College– Cafeteria**	2,713	0.79	Nursing Homes	5,840	0.92
College – Classes	2,586	0.54	Office (General Office Types)**	3,013	0.92
College - Dormitory	3,066	0.92	Parking Garages	4,368	0.0
Commercial Condos***	3,100	0.92	Parking Garages (24/7)	7,717	0.0
Convenience Stores	6,376	0.97	Parking Lots	4,100	0.0
Convention Center	1,954	0.89	Penitentiary	5,477	0.37
Court House	3,748	0.92	Performing Arts Theatre	2,586	0.89
Dining: Bar Lounge/Leisure	4,182	0.79	Police / Fire Stations (24 Hr)	7,665	0.89
Dining: Cafeteria / Fast Food	6,456	0.79	Post Office	3,748	0.97
Dining: Family	4,182	0.79	Pump Stations	1,949	0.67
Entertainment	1,952	0.89	Refrigerated Warehouse	2,602	0.67
Exercise Center	5,836	0.89	Religious Building	1,955	0.89
Fast Food Restaurants	6,376	0.79	Restaurants	4,182	0.79
Fire Station (Unmanned)	1,953	0.89	Retail	3,463	0.85
Food Stores	4,055	0.98	School / University	2,187	0.54
Gymnasium	2,586	0.89	Schools (Jr./Sr. High)	2,187	0.54

[74] ConEd Large C&I Program Impact and Process Evaluation Report prepared by Navigant, August 2019, slide 71.
[75] ConEd Large C&I Program Impact and Process Evaluation Report prepared by Navigant, August 2019, slide 71.

Facility Type	Lighting Hours (hrs/yr)	CF[74]	Facility Type	Lighting Hours (hrs/yr)	CF[75]
Hospitals	7,674	0.74	Schools (Preschool/ Elementary)	2,187	0.54
Hospitals / Health Care	7,666	0.74	Schools (Technical/ Vocational)	2,187	0.54
Industrial - 1 Shift	2,857	0.67	Small Services	3,750	0.92
Industrial - 2 Shift	4,730	0.67	Sports Arena	1,954	0.89
Industrial - 3 Shift	6,631	0.67	Town Hall	3,748	0.89
Laundromats	4,056	0.89	Transportation	6,456	0.89
Library	3,748	0.89	Warehouse (Not Refrig-erated)	2,602	0.67
Light Manufacturers**	2,613	0.67	Waste Water Treatment Plant	6,631	0.67
Lodging (Hotels/Mo-tels)	3,064	0.92	Workshop	3,750	0.67
Mall Concourse	4,833	0.85			

* New car showrooms and Big Box retail stores with evening and/or weekend hours should use the Facility Type "Retail" for lighting operating hours.
** Lighting operating hours data from the 2008 California DEER Update study
*** Lighting operating hours data for offices used

Example Calculation *(Not to be used as default)*

60 3-lamp, 4-foot T8 fluorescent fixtures in an elementary school near Albany are relamped with DLC qualified LED linear tube lamps. The wattage of the existing fixtures is approximately 88 W. Following relamp, the fixture wattage is reduced to 36 W. The fixtures are on 2,200 hours per year. The school building has central air conditioning and gas heat. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below.

$$\Delta kWh = \left[\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right] \times hrs \times (1 + HVAC_c)$$

$$\Delta kW = \left[\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right] \times (1 + HVAC_d) \times CF$$

$$\Delta MMBtu = \left[\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right] \times hrs \times HVAC_{ff}$$

$units_{baseline}$= 60, from application.
$units_{ee}$= 60, from application.
$W_{baseline}$ = 88, from application
W_{ee} = 36, from application
$hrs_{operating}$ = 2,200 hours/year, from application

$HVAC_c$= 0.0552, from Appendix D based on building type, city and fuel type
$HVAC_d$= 0.1478, from Appendix D based on building type, city and fuel type
$HVAC_{ff}$= -0.0011, from Appendix D based on building type, city and fuel type
CF= 0.54, from Operating hours section based on Facility type

$$kWh = \left[\frac{(80 \times 68) - (36 \times 60)}{1{,}000}\right] \times 2{,}200 \times (1 + 0.0552) = 7{,}614.32\ kWh$$

$$\Delta kW = \left[\frac{(88 \times 60) - (36 \times 60)}{1{,}000}\right] \times (1 + 0.1478) \times 0.54 = 1.933\ kW$$

$$\Delta MMBtu = \left[\frac{(88 \times 60) - (36 \times 60)}{1{,}000}\right] \times 2{,}200 \times -0.0011 = -7.55\ MMBtu$$

60, 30W bulbs are being installed in a newly constructed small commercial auto parts facility that originally installed 70W T-12 that operates 2,500 hours a year and has 4,500 square ft. The shop is located in Albany and has central AC and electric heat. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are calculated as below. Annual Fossil Fuel Energy Savings are not applicable.

$$\Delta kWh = SF \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times hrs \times (1 + HVAC_c)$$

$$\Delta kW = SF \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times (1 + HVAC_d) \times CF$$

$$\Delta MMBtu = SF \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times hrs \times HVAC_{ff}$$

SF = 4,500, from application
$LPD_{baseline}$ = 0.93, 70X60=4,200/4,500, from application
LPD_{ee} = 0.40, 60X30 =1,800/4,500 from application
Hrs = 2,500, from application
$HVAC_c$ = -0.2114, from Appendix D based on building type, city and fuel type
$HVAC_d$ =0.1478, from Appendix D based on building type, city and fuel type
$HVAC_{ff}$ = 0.000, from Appendix D based on building type, city and fuel type
CF = 0.89, from Operating hours section based on Facility type

$$\Delta kWh = 4{,}500 \times \left[\frac{0.93 - 0.40}{1{,}000}\right] \times 2{,}500 \times (1 + (-0.2114)) = 4{,}702.02\ kWh$$

$$\Delta kW = 4{,}500 \times \left[\frac{0.93 - 0.40}{1{,}000}\right] \times (1 + 0.1478) \times 0.89 = 2.436\ \text{kW}$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

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