Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
12-19-4	A	12/23/2019	12/23/2019	R/MF Fireplace	New Measure	Pg. xx
12-19-5	A	12/23/2019	12/23/2019	R/MF Smart Thermostatic Radiator Enclosure	New Measure	Pg. xx
12-19-6	R	12/23/2019	12/23/2019	R/MF Interior and Exterior Lighting	Removed language regarding EISA 2020 backstop legislation	Pg. 193
12-19-9	A	12/23/2019	12/23/2019	C/I Conveyor Broiler	New Measure	Pg. xx
12-19-10	A	12/23/2019	12/23/2019	C/I Infrared Charbroiler	New Measure	Pg. xx
12-19-11	A	12/23/2019	12/23/2019	C/I Infrared Salamander Broiler	New Measure	Pg. xx
12-19-12	R	12/23/2019	12/23/2019	C/I Window - Glazing	Updated baseline language to reflect contents of Appendix F	Pg. 280
12-19-13	A	12/23/2019	12/23/2019	C/I Electronically Commutated (EC) Motor – Hydronic Circulator Pump	New Measure	Pg. xx
12-19-14	A	12/23/2019	12/23/2019	C/I Kitchen Demand Control Ventilation (KDCV)	New Measure	Pg. xx
12-19-17	R	12/23/2019	12/23/2019	Appendix P	Updated EUL entries for all measures contained in this Record of Revision	Pg. 765

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between September 28, 2019 – December 23, 2019.

APPLIANCE

FIREPLACE

Measure Description

This measure covers the installation of direct-vented, gas fireplaces with fireplace efficiency (FE) greater than or equal to 70% tested in accordance with the Canadian Standards Association (CSA) CSA-P.4 method and electric, intermittent pilot lights. This measure is only applicable to the installation of gas fireplaces for use as a supplemental heat source.

This analysis leverages the DOE Technical Support Document (TSD) for baseline fireplaces and pilot lights, a survey of US utilities for efficient fireplaces, and the Iowa Technical Reference Manual,[1] for the algorithm used to estimate savings.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \Delta kWh_{PilotLight}$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = units \times \left[\frac{kBTUh_{in}}{100} \times \left(\frac{1}{FE_{baseline}} - \frac{1}{FE_{ee}}\right) \times hrs + \Delta therm_{PilotLight}\right]$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
$\Delta kWh_{PilotLight}$	= Change in electric consumption of pilot light
$kBTUh_{in}$	= Input capacity of fireplace in kBTU/h
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure
FE	= Rated efficiency of fireplace
hrs	= Annual operating hours of fireplace
$\Delta therm_{PilotLight}$	= Change in gas consumption of pilot light
100	= Conversion factor, one therm equals 100 kBTU

[1] Iowa Energy Efficiency Statewide Technical Reference Manual, Version 3.0, September 2018

Summary of Variables and Data Sources

Variable	Value	Notes
$\Delta kWh_{PilotLight}$	-13.6	Baseline direct, vented gas fireplaces with a standing pilot light consumes no electric energy but consumes gas energy. Intermittent pilot lights consume electricity but save gas.[2]
$kBTUh_{in}$		From application
$FE_{baseline}$	0.64	Average efficiency of baseline fireplace[3]
FE_{ee}		From application.
hrs	157	Annual hours of use of fireplace[4]
$\Delta therm_{PilotLight}$	34.9	Average therm savings from switching from baseline, standing pilot light to intermittent pilot light[5]

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is N/A. While there is an electric energy penalty due to the intermittent pilot light, there are no recommended demand savings due to fireplaces being operated during the heating season.[6]

Baseline Efficiencies from which Savings are Calculated

The baseline fireplace, as defined by DOE, is a direct-vented, gas fireplace with an FE of 64% and a standing pilot light.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a direct-vented gas fireplace with an FE of 70% or greater tested in accordance with the Canadian Standards Association (CSA) CSA-P.4 method and an intermittent pilot light.

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[2] DOE Technical Savings Document, Table 7.4.1: Average Annual Energy Consumption and Savings for Hearth Products

[3] DOE Technical Savings Document, page 7-7.

[4] DOE Technical Savings Document, Table 7.3.5: Range of Burner Operating Hours for Hearth Products

[5] DOE Technical Savings Document, Table 7.4.1: Average Annual Energy Consumption and Savings for Hearth Products

[6] Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products. Chapters 7 and 8. The most common form of electronic ignition system found in hearth products is the intermittent pilot ignition. In an intermittent pilot ignition, the pilot light is only lit when there is a call for heat, and the pilot light is automatically extinguished after the burner is turned off. In order to ignite the pilot light, these systems require an outside power source, often supplied by either a battery or an electrical connection.

Operating Hours

The operating hours are assumed to be 157 hours per year. This assumption is based on the average of the range of hearth product burner operating hours among sample households.[7]

Effective Useful Life (EUL)

See Appendix P.

Ancillary Electric Savings Impacts

N/A

Ancillary Fossil Fuel Savings Impacts

N/A

References

1. Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products. Chapters 7 and 8. Department of Energy (DOE). January 30, 2015.
   Available from: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0002.
2. A survey of US utilities offering rebates for high efficiency fireplaces and/or fireplaces with intermittent pilot lights found the minimum qualifying FE to be 70%. Utilities and organizations include Energy Trust of Oregon, CenterPoint Energy, Puget Sound Energy, Minnesota Energy Resources, and Dominion Energy Utah. Retrieved using *E-Source*.
3. Iowa Utilities Board. "Iowa Energy Efficiency Statewide Technical Reference Manual Version 3.0. Volume 2: Residential Measures." Section 2.4.9. September 14, 2018. Available from: https://efs.iowa.gov/cs/groups/external/documents/docket/mdax/oda0/~edisp/1804812.pdf

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[7] Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products. Table 7.3.5.

HEATING, VENTILATION AND AIR CONDITIONING (HVAC) - CONTROL

SMART THERMOSTATIC RADIATOR ENCLOSURE (TRE)

Measure Description

This measure is applicable to the installation of **S**mart Thermostatic Radiator Enclosures (TRE). Smart TREs are insulated radiator covers with integrated temperature controls and sensors. These systems allow for the control of heat energy transfer from the radiator to a room, while enabling feedback to the heating plant to optimize building-wide energy consumption. Each radiator cover incorporates a thermostatically-controlled fan, which operates based on the room temperature and the temperature set-point (set by the user and/or the designated operator). An integrated radio in the cover communicates room and radiator temperature in real-time to centralized systems and instructs the system to provide heating only when necessary.

TREs demonstrate significant savings opportunities in buildings with heating distribution imbalances and perform best when combined with other steam system best practices improvements. This measure is only applicable in buildings with one or two-pipe steam space heating. This measure is only applicable when 60% or more of a building's radiators are retrofitted with TREs to ensure the benefits of system network communication.[8]

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = -(units \times kWh_{TRE})$$

Summer Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings[9]

$$\Delta therms = (F_{ratio} \times HEI + F_{lower\ bound}) \times heating_{annual}$$

where:

$$HEI = \frac{BTU/ft^2}{HDD}$$

[8] A majority of a building's radiators must be retrofitted with smart TREs for the system to realize the savings presented in this measure, which is dependent upon temperature and air flow communication throughout the building. While the implementation rate is typically expected to be higher, this measure is subject to diminishing returns, which become appreciable at approximately 60% implementation. For example, kitchens and bathrooms often experience unpredictable temperature loads and smart TREs in such rooms may not increase heating system efficiency.

[9] Annual Gas Energy Savings equation developed based on a linear regression analysis comparing building heating therm savings and Heating Energy Intensity (HEI).

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of TREs installed under the program
kWh_{TRE}	= Annual electric consumption of smart TRE
HEI	= Building Heating Energy Intensity
BTU	= Annual space heating fuel consumption, in BTUs
ft^2	= Conditioned square footage of building
HDD	= Heating Degree Days based on location
F_{ratio}	= Factor, observed ratio of percent savings to existing building HEI`1
$F_{lower\ bound}$	= Factor, observed lower bound of percent savings[10]
$heating_{annual}$	= Annual heating consumption of building, in therms

Summary of Variables and Data Sources

Variable	Value	Notes
kWh_{TRE}	7	Empirically determined consumption of smart TRE[11]
HEI		From application. Building Heating Energy Intensity is the heating energy consumed by a building in one year (in BTU) divided by the total conditioned square footage of the building divided by local annual heating degree days. Each component is further outlined below. If billing data is not available, use a value of 10.5 as a default. Default HEI was calculated by multiplying a weighted average of New York City residential building gas EUI values[12] for steam systems by 0.72 to establish space heating HEI[13], and dividing by New York City HDD.

[10] Value represents the y-intercept of linear regression analysis.

[11] NYSERDA ETAC-EPV-001: Radiator Labs Energy Performance Validation Project, page 2

[12] Local Law 84 data via Urban Green Council, Demystifying Steam, February 2019, Table 2: Total Building Floor Area by Heating System Type and Building Size, and Table 3: Baseline Fuel Use and Estimated Savings from Boiler and Distribution Improvements

[13] Local Law 84 and Local Law 87 as cited in Urban Green Council, Demystifying Steam, February 2019, page 22

Variable	Value	Notes
BTU		From application, annual space heating fuel consumption, from billing data. If annual space heating fuel consumption is not known, multiply total annual energy consumption (electric and fuel, in BTU) by 0.61 for single family homes or 0.41 for multifamily buildings to derive default annual space heating BTU.[14] If using the default HEI value cited above, BTU is already accounted for in that value.
ft^2		From application, total conditioned building square footage.
HDD		If using billing data to develop HEI, look up based on location from Heating Degree Days section below. Otherwise, HDD is accounted for in the default HEI value cited above.
$heating_{annual}$		From application, annual space heating consumption of building, in therms. If annual space heating consumption of building is not known, derive $heating_{annual}$ by the following methods depending on available data: 1. If total annual energy consumption is known, multiply total annual energy consumption (electric and fuel, in BTU) by 0.61 for single family homes or 0.41 for multifamily buildings and divide the result by 100,000 to derive $heating_{annual}$ (in therms).[15] 2. If using the default HEI value cited above, multiply default HEI by conditioned square footage and by HDD (look up based on location from Heating Degree Days section below), then divide the result by 100,000 to derive $heating_{annual}$ (in therms).[16]

[14] EIA Residential Energy Consumption Survey (RECS) 2015 for the Northeast, Table CE3.2. Blended averages are developed for single family data and for multifamily space heating consumption data compared to total building consumption data.

[15] EIA Residential Energy Consumption Survey (RECS) 2015 for the Northeast, Table CE3.2. Blended averages are developed for single family data and for multifamily space heating consumption data compared to total building consumption data.

[16] Urban Green Council, Demystifying Steam, February 2019. Typical HEI of 10.5 developed by multiplying a weighted average of fuel EUI (Table 2 of report) by 0.72 (page 22 of report) to derive space heating HEI for steam systems and dividing by NYC HDD to derive HEI in BTU/SF/HDD.

Variable	Value	Notes
F_{ratio}	0.018	Based on slope of linear regression analysis comparing building heating therm savings and HEI[17]. For additional detail on the derivation of this value, refer to the "NY TRM - Smart Thermostatic Radiator Enclosure - Supplement.xlsx" workbook.
$F_{lower\ bound}$	0.020	Based on intercept of linear regression analysis comparing building heating therm savings and HEI[18]. For additional detail on the derivation of this value, refer to the "NY TRM - Smart Thermostatic Radiator Enclosure - Supplement.xlsx" workbook.

Heating Degree Days

For the purposes of this measure, Heating Degree Days are defined as 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 HDD values listed in the table below are based on 30-year averages of U.S annual climate normals for the period of 1981 to 2010 using base 65° F.[19]

City	HDD
Albany	6,680
Binghamton	7,193
Buffalo	6,617
Massena	8,196
NYC	4,671
Poughkeepsie	6,210
Syracuse	6,651

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 exposed radiator in a one or two-pipe space heating steam system.

[17] Savings analysis based on "A focused Demonstration Project; the 'Cozy' by Radiator Labs" (NYSERDA, 2016) and "Radiator Labs Energy Performance Validation Project" (NYSERDA, 2018).
[18] Ibid
[19] HDD taken from NCEI 1981-2010 climate normals

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a radiator equipped with a smart TRE in a one or two-pipe space heating steam system. At least 60% of the building's radiators must be retrofitted with smart TREs with radio communication capability between the heating system and individual TREs. Smart TREs must be insulation rated to R-3 and be UL certified.

Operating Hours

Operating hours are not directly applied in this methodology and are therefore not explicitly defined for this measure. However, consideration of system operating hours is embedded in normalized, location-dependent heating degree days.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Smart TRE building implementation incorporates radio communication between radiators and the central heating system. Building wide integration enables monitoring of whole system and tracking of potential issues in real time, notifying building owners of issues with steam traps and risers, unexpected heating flow or blockage, etc. These impacts are not considered in the prescribed savings methodology for this measure.

Ancillary Electric Savings Impacts

Each radiator cover has a circulation fan that cycles on each time that the infrared thermostat indicates that heating is required. As a result, the installation of this system results in a marginal increase in electric energy use. This impact is addressed in this measure.

References

1. NYSERDA Report Number 18-12, "A Focused Demonstration Project: The "Cozy" by Radiator Labs"
   Available from: https://www.radiatorlabs.com/wp-content/uploads/2018/10/Radiator-Labs.Cozy_.NYSERDA-Report.2018.pdf
2. NYSERDA ETAC-EPV-001: Radiator Labs Energy Performance Validation Project
   Available from: https://www.radiatorlabs.com/wp-content/uploads/2016/08/RADLABS_NYSERDA_ETAC_Report_Final.pdf
3. BizEE Degree Days; Weather Data for Energy Professionals
   Available from: https://www.degreedays.net/
4. NOAA National Centers for Environmental Information – NCEI 1981-2010 Normals
   Available from: http://www.ncdc.noaa.gov/cdo-web/datatools/normals
5. Urban Green Council, Demystifying Steam, February 2019
   Available from: https://www.urbangreencouncil.org/sites/default/files/2019.02.12_demystifying_steam_report.pdf

6. EIA Residential Energy Consumption Survey (RECS) 2015 Survey Data End-Use Consumption in the Northeast
Available from:
https://www.eia.gov/consumption/residential/data/2015/index.php?view=consumption

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LIGHTING

INTERIOR AND EXTERIOR LIGHTING

Measure Description

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

Beginning January 2014, the Energy Independence and Security Act of 2007 (EISA) regulations stipulated typical 60W and 40W lamp wattages to comply with 43W and 29W lamp wattage standards for rated lumen output ranges of 750-1049 and 310-749 lumens, respectively. Deemed baseline values for this measure will apply wattages based on lamp type and light output (lumens).[20]

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 Gas Energy Savings

$$\Delta therms = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_g$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Summer Peak Coincident Demand Savings
Δtherms = Annual gas energy savings
units = Number of measures installed under the program
W = Rated wattage of lamp and/or fixture (Watts)
baseline = Baseline condition or measure
ee = Energy efficient condition or measure
1,000 = Conversion factor, one kW equals 1,000 Watts
CF = Coincidence factor
hrs = Lighting operating hours

[20] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 86

$HVAC_c$ = HVAC interaction factor for annual electric energy consumption
$HVAC_d$ = HVAC interaction factor for peak demand at NYISO coincident summer peak hour
$HVAC_g$ = HVAC interaction factor for annual natural gas consumption (therms/kWh)

Summary of Variables and Data Sources

Variable	Value	Notes
units		Number of lamps sold/distributed under the program, from application
W_{ee}		Energy efficient measure Watts, from application
$W_{baseline}$		Baseline measure Watts, from application or default values from applicable table in "Baseline Efficiencies…" section below. Existing wattage shall be used when known. Baseline tables (below) shall be used when program structure does not allow for collection of existing conditions (e.g., point-of-sale rebates).
hrs	Interior Lamps: 1,168 Interior Fixtures: 913 Exterior: 1,643	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.
$HVAC_c$	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.
$HVAC_g$	Exterior and Unconditioned Space: 0	HVAC interaction factor for annual natural gas energy consumption (therms/kWh). Vintage and HVAC type weighted average by city. See Appendix D.
CF	Interior: 0.082 Exterior: 0	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

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 0.082. This factor was derived from an examination of studies throughout New England that calculated coincidence factors based on the definition of system peak period at the time, as specified by ISO-New England.[21]

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

Rated wattage baseline values should reflect the guidance noted below based on bulb type and lumens in accordance with EISA standards.[22]

<u>General Service Lamps</u>
Baseline wattage for general service lamps are found in the table below. Per EISA 2007 guidelines, a general service lamp is defined as a standard incandescent or halogen type lamp that:

(1) Is intended for general service applications;
(2) Has a medium screw base;
(3) Has a lumen range of not less than 310 lumens and not more than 2,600 lumens
(4) Is capable of being operated at voltage range at least partially within 110 and 130 volts.

Certain lamp types are exempt from EISA compliance, including reflector lamps (see Reflector/Flood Lamps section below), decorative and globe shape lamps (see Specialty Lamps section below) and three-way lamps. Baseline wattage for any of these exempt lamp types shall reflect the values in column (c) of the table below, with the exception of those lamps defined in the Specialty Lamps or Reflector/Flood Lamps sections. All other general service lamps shall use the baseline wattage values in column (b), corresponding to the applicable lumen range identified in column (a). For standard lamps that fall outside of the prescribed lumen ranges below, the manufacturer recommended baseline wattage shall be used. For a complete list and definitions of EISA-exempt lamp types, reference Sec. 321: Efficient Light Bulbs of Public Law 110-140.[23]

Lumen Range (a)	Post-EISA 2007 Incandescent Equivalent $W_{baseline}$ (b)	EISA-Exempt Incandescent Equivalent $W_{baseline}$ (c)
310 – 449	25	25
450 – 799	29	40
800 – 1,099	43	60
1,100 – 1,599	53	75
1,600 – 1,999	72	100
2,000 – 2,600	72	150

[21] Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, Spring 2007, Table i-1
[22] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 89
[23] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 82-86

Specialty Lamps[24]

Baseline wattage for specialty lamps are found in the table below. Specialty lamps are defined as medium screw-base lamps that are globe, bullet, candle or decorative shaped. For specialty lamps that fall outside of the prescribed lumen ranges below, the manufacturer recommended baseline wattage should be used.

Lumen Range (decorative) (a)	Lumen Range (globe) (b)	Post-EISA 2007 Incandescent Equivalent $W_{baseline}$ (c)	EISA-Exempt Incandescent Equivalent $W_{baseline}$ (d)
70 – 89		10	10
90 – 149		15	15
150 – 299	250 – 349	25	25
300 – 499	350 – 499	29	40
500 – 699	500 – 574	43	60
	575 – 649	53	75
	650 – 1,099	72	100
	1,100 – 1,300	72	150

Reflector/Flood Lamps[25]

Baseline wattage for reflector and flood type lamps are found in the table below. For reflector and flood lamps that fall outside of the prescribed lumen ranges below, the manufacturer recommended baseline wattage should be used.

Bulb Type (a)	Lumen Range (b)	$W_{baseline}$ (c)
ER30, BR30, BR40, or ER40	200 – 299	30
	300 – 449	40
	450 – 499	45
	500 – 1,419	65
R20	200 – 299	30
	300 – 449	40
	400 – 449	40
	450 – 719	45
All other R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.25", other than those listed above	200 – 299	30
	300 – 599	40
	600 – 849	50
	850 – 999	55
	1,000 – 1,300	65

[24] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 21: Residential Lighting Evaluation Protocol, National Renewable Energy Laboratory, December 2014, p. 8-11

[25] State of Pennsylvania Technical Reference Manual, PA Public Utilities Commission, June 2016, p. 21-22

Compliance Efficiency from which Incentives are Calculated

Compliance efficiency and fixture/lamp specifications shall be dictated by program eligibility criteria.

Operating Hours

Lamps

Hours of operation for lamps are estimated to be 3.2 operating hours per day or 1,168 (3.2 x 365) hours per year. The 3.2 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island, and Vermont[26] . The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day, based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 4.8 hours from the markdown program component and 3.2 from the coupon program component[27]. This value represents a trade-off among factors that may affect the extent to which any out-of New York State value is applicable to NY. These include such factors as differences between the study area and NY, related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 3.2 appears to be the most reasonable prior to New York-specific impact studies. This value is appropriate for interior applications only. For exterior applications, assume a total of 1,643 hours which is based on updated results from the 2003 Nexus Market Research[28].

Fixtures

Hours of operation for fixtures are estimated to be 2.5 operating hours per day or 913 (2.5 x 365) hours per year. The 2.5 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island and Vermont[29]. The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day, based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 2.4 for interior fixtures[30]. The proposed value represents a trade-off among factors that may affect the extent to which any value from outside of New York State is applicable to NY. These include such factors as differences between the study area and NY related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 2.5 appears to be the most reasonable prior to New York specific impact studies.

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[26] “Extended residential logging results” by Tom Ledyard, RLW Analytics Inc. and Lynn Heofgen, Nexus Market Research Inc., May 2, 2005, p.1

[27] Process and Impact Evaluation of the Efficiency Maine Lighting Program, RLW Analytics, Inc, and Nexus Market Research Inc., April 10, 2007, Table 1-2, p. 12.

[28] Updated results from Nexus Market Research, “Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs”, Final Report, October 1, 2004, presented in 2005 memo; https://library.cee1.org/content/impact-evaluation-massachusetts-rhode-island-and-vermont-2003-residential-lighting-programs

[29] “Extended residential logging results” by Tom Ledyard, RLW Analytics Inc. and Lynn Heofgen, Nexus Market Research Inc., May 2, 2005, p.1

[30] Process and Impact Evaluation of the Efficiency Maine Lighting Program, RLW Analytics, Inc, and Nexus Market Research Inc., April 10, 2007, Table 1-2, p. 12.

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.

References

1. Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 82-86
   Available from: https://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf
2. Impact evaluations of residential lighting programs in several New England states reviewed in preparing the proposed hours-of-use values and coincidence factors include:
   a. Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs, prepared for Cape Light Compact, Vermont Public Service Department, National Grid Massachusetts and Rhode Island, Western Massachusetts Electric Company, NSTAR Electric, Fitchburg G&E by Nexus Market Research Inc., and RLW Analytics Inc., Oct 1, 2004.
      Available from: https://library.cee1.org/system/files/library/1308/485.pdf
   b. Extended Residential Logging Results memo to Angela Li, National Grid, by Tom Ledyard, RLW Analytics Inc., and Lynn Hoefgen, Nexus Market Research Inc., May 2, 2005
   c. Market Progress and Evaluation Report for the 2005 Massachusetts ENERGY STAR® Lighting Program, prepared for Cape Light Compact, National Grid – Massachusetts, NSTAR, Western Massachusetts Electric Company by Nexus Market Research Inc, RLW Analytics, Inc., Shel Feldman Management Company, Dorothy Conant. September 29, 2006.
      Available from: https://library.cee1.org/system/files/library/1297/474.pdf
   d. Process and Impact Evaluation of the Efficiency Maine Lighting Program, prepared for Efficiency Maine by Nexus Market Research Inc. and RLW Analytics Inc., April 10, 2007.
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3. Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures - For use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM), prepared for the New England State Program Working Group by RLW Analytics Inc., Spring 2007.
Available from:
https://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/116_RLW_CF%20Res%20C&I%20ltg.pdf
4. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 21: Residential Lighting Evaluation Protocol, National Renewable Energy Laboratory, December 2014, p. 8-11.
Available from: http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf
5. State of Pennsylvania Technical Reference Manual, PA Public Utilities Commission, June 2016, p. 21-22
Available from:
http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
7-13-2	7/31/2013
6-15-3	6/1/2015
1-16-3	12/31/2015
1-17-4	12/31/2016
9-17-2	9/30/2017
12-19-6	12/23/2019

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CONVEYOR BROILER

Measure Description

This measure covers the installation of efficient gas-fired conveyor broilers. Conveyor broilers are broilers fitted with a belt that transports food between a set of two or more heating radiants that are above and below the belt, while consistently cooking the food. They are less labor intensive than standard broilers while allowing high production output. Qualifying conveyor broilers must have a catalyst and an input rate less than 80 kBTU/h or a dual stage or modulating gas valve with a capability of throttling the input rate below 80 kBTU/h.

Gas-fired conveyor broilers may also be equipped with an electric bun grill and/or electric heating/warming elements. Gas-fired conveyor broilers are only eligible for electric savings when equipped with an electric bun grill and/or electric heating/warming elements.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings (Use only when efficient measure includes electric equipment as described in Measure Description)

$$\Delta kWh = units \times (\Delta kWh/unit)$$

Summer Peak Coincident Demand Savings (Use only when efficient measure includes electric equipment as described in Measure Description)

$$\Delta kW = units \times (\Delta kW/unit)$$

Annual Gas Energy Savings (Gas Equipment Only)

$$\Delta therms = units \times (\Delta therms/unit)$$

where:

ΔkWh = Annual electricity energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings
(ΔkWh/unit) = Annual electric savings per unit
(ΔkW/unit) = Summer Peak Coincident Demand Savings per unit
(Δtherms/unit) = Annual gas savings per unit

Summary of Variables and Data Sources

Variable	Value	Notes
(ΔkWh/unit)		Look up from table below based on belt width.
(ΔkW/unit)		Look up from table below based on belt width.
(Δtherms/unit)		Look up from table below based on belt width.

Unit Energy Savings[31]

Belt Width (inches)	ΔkWh/unit	ΔkW/unit	Δtherms/unit
< 20 inches	7,144	1.48	1,145
≥ 20 inches and ≤ 28 inches	6,403	0.88	1,933
> 28 inches	23,849	3.29	3,161

Coincidence Factor (CF)

The prescribed value for the coincidence factor is N/A. Peak coincidence is embedded in ΔkW/unit value above.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline case for this measure is an automatic conveyor broiler capable of maintaining a temperature above 600°F with a tested idle rate greater than 40 kBTU/h for a belt width narrower than 20", greater than 60 kBTU/h for a belt width between 20" and 28", greater than 70 kBTU/h for a belt width wider than 28".

Compliance Efficiency from which Incentives are Calculated

The compliance case is an automatic conveyor broiler with a catalyst and an input rate less than 80 kBTU/h, or a dual stage or modulating gas valve with the capability of throttling the input rate below 80 kBTU/h. The compliance broiler must be of similar size or smaller than the baseline condition.

Operating Hours

Operating hours are embedded into the unit energy savings above. Market analysis found that conveyor broilers are mostly installed in quick service restaurants and are turned on an hour prior to their opening, resulting in an average operation of 18.3 hours per day.[32]

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

More efficient food service equipment rejects less heat into the condition space than standard equipment, increasing space heating requirements while decreasing cooling load. However, no relevant studies have been performed to date that would allow quantification of these impacts. Until additional information is available, these impacts are excluded from the prescribed formulation of savings.

[31] Southern California Gas Company, Work Paper *WPSCGNRCC171226A* Commercial Conveyor Broilers, pg 2
[32] Technical Support Document: 50% Energy Savings for Quick-Service Restaurants. Hours of operation and daily energy use were collected from field monitoring data conducted by PG&E and SoCalGas from four quick service restaurant chains. Average hours from Figure 2.7 as cited in SoCalGas WPSCGNRCC171226A workpaper.

Ancillary Electric Savings Impacts

More efficient food service equipment rejects less heat into the condition space than standard equipment, increasing space heating requirements while decreasing cooling load. However, no relevant studies have been performed to date that would allow quantification of these impacts. Until additional information is available, these impacts are excluded from the prescribed formulation of savings

References

1. Southern California Gas Company, Work Paper *WPSCGNRCC171226A* Commercial Conveyor Broilers, Revision 01, March 21, 2019
   Available from: http://deeresources.net/workpapers
2. Technical Support Document: 50% Energy Savings for Quick-Service Restaurants, Available from:
   http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19809.pdf

Record of Revision

Record of Revision Number	Issue Date
12-19-9	12/23/2019

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APPLIANCE

INFRARED CHARBROILER

Measure Description

This measure covers the installation of infrared charbroilers. A charbroiler, also known as a chargrill or simply a broiler, contains a heat source underneath a sturdy grate to cook food. An infrared charbroiler operates through radiant rather than a combination of convective and radiant heat transfer.

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 Gas Energy Savings

$$\Delta therms = units \times days \times \frac{\left(\Delta BTU_{preheat} + \Delta BTU_{cooking}\right)}{100{,}000}$$

where:

$$\Delta BTU_{preheat} = \left(BTU/h_{preheat,baseline} - BTU/h_{preheat,ee}\right) \times N_{preheat} \times hrs_{preheat}$$

$$\Delta BTU_{cooking} = \left(BTU/h_{cooking,baseline} - BTU/h_{cooking,ee}\right) \times Cycle \times hrs_{cooking}$$

$$hrs_{cooking} = hrs - (hrs_{preheat} \times N_{preheat})$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
$\Delta BTU_{preheat}$	= Daily preheat energy savings
$\Delta BTU_{cooking}$	= Daily cooking energy savings
units	= Number of measures installed under the program
days	= Operating days per year
$_{baseline}$	= Baseline condition or measure
$_{ee}$	= Energy efficient condition or measure
$BTU/h_{preheat}$	= Equipment preheat energy rate (BTU/h)
$N_{preheat}$	= Number of preheats per day
$BTU/h_{cooking}$	= Equipment cooking energy rate (BTU/h)

Cycle = Duty cycle
hrs = Daily operating hours
$hrs_{preheat}$ = Preheat duration (hours)
$hrs_{cooking}$ = Daily operating hours excluding preheat time
100,000 = Conversion factor (BTU/therm), one therm equals 100,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
$BTU/h_{preheat,baseline}$	64,000	FSTC Gas Broiler Life-Cycle Cost Calculator[33]
$BTU/h_{preheat,ee}$	54,000	FSTC Gas Broiler Life-Cycle Cost Calculator[34]
$N_{preheat}$	1	Pacific Gas and Electric.[35]
hrs		From application. Otherwise, look up based on facility type in the Hours/Day column of the Operating Hours table below.
$hrs_{preheat}$	0.25	FSTC Commercial Cooking Appliance Technology Assessment[36]
$hrs_{cooking}$	$= hrs - (hrs_{preheat} \times N_{preheat})$	
$BTU/h_{cooking,baseline}$	140,000	FSTC Gas Broiler Life-Cycle Cost Calculator[37]
$BTU/h_{cooking,ee}$	105,000	FSTC Gas Broiler Life-Cycle Cost Calculator[38]
Cycle	0.8	FSTC Commercial Cooking Appliance Technology Assessment[39]
days		From application or look up based on facility type in the Days/Year column of the Operating Hours table below.

Coincidence Factor (CF)

The prescribed coincidence factor is N/A

Baseline Efficiencies from which Energy Savings are Calculated

The baseline case for this measure is a charbroiler that contains a heat source underneath a sturdy grate to cook food with a combination of radiant, conductive, and convective heat.

[33] FSTC Gas Broiler Life-Cycle Cost Calculator, referenced by the the Illinois TRM Version 7.0, pg 68
[34] Ibid
[35] Ibid
[36] FSTC Commercial Cooking Appliance Technology Assessment, page 4-13
[37] FSTC Gas Broiler Life-Cycle Cost Calculator, referenced by the the Illinois TRM Version 7.0, pg 68
[38] Ibid
[39] FSTC Commercial Cooking Appliance Technology Assessment, Table 4-3

Compliance Efficiency from which Incentives are Calculated

The compliance case is a charbroiler with infrared heating elements.

Coincidence Factor (CF)

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

Operating Hours

Equipment operating hours per day and days per year shall be taken from the application if known. Default operating hours per day and days per year are provided below, established based on a weighted average of values associated with similar facility types, as reported by the California Energy Commission.[40]

Facility Type	Hours/Day	Days/Year
Community College	11	283
Fast Food	14	363
Full Service Restaurant	12	321
Grocery	12	365
Hospital	11	365
Hotel	20	365
Miscellaneous	9	325
Motel	20	365
Primary School	5	180
Secondary School	8	180
Small Office	12	250
University	11	283

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

More efficient food service equipment rejects less heat into the condition space than standard equipment, increasing space heating requirements while decreasing cooling load. However, no relevant studies have been performed to date that would allow quantification of these impacts. Until additional information is available, these impacts are excluded from the prescribed formulation of savings.

Ancillary Electric Savings Impacts

More efficient food service equipment rejects less heat into the condition space than standard equipment, increasing space heating requirements while decreasing cooling load. However, no

[40] California Energy Commission, Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Foodservice Equipment, Appendix E

relevant studies have been performed to date that would allow quantification of these impacts. Until additional information is available, these impacts are excluded from the prescribed formulation of savings.

References

1. Food Service Technology Center, Commercial Cooking Appliance Technology Assessment, prepared for Enbridge Gas Distribution and Pacific Gas and Electric Company, by Fisher-Nickel Inc., 2002
   Available from:
   https://fishnick.com/equipment/techassessment/Appliance_Tech_Assessment.pdf
2. 2019 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 7.0. September 13, 2018 (accessed July 28, 2019) Available from: http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/Final/2019_IL-TRM_Version_7.0_dated_Sept-13-2018_Final_Volumes_1-4_Compiled.pdf
3. California Energy Commission, Energy Research and Development Division, Characterizing the Energy Efficiency Potential of Gas-Fired Commercial Foodservice Equipment, October 2014.
   Available from: http://www.energy.ca.gov/2014publications/CEC-500-2014-095/CEC-500-2014-095.pdf

Record of Revision

Record of Revision Number	Issue Date
12-19-10	12/23/2019

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APPLIANCE

INFRARED SALAMANDER BROILER

Measure Description

This measure covers the installation of gas-fired, commercial standalone infrared salamander broilers. Infrared broilers operate through radiant rather than convective heat transfer. Salamander broilers are used for broiling, browning, caramelizing, glazing, grilling, and toasting. Also known as back shelf broilers, they are particularly common for searing proteins such as beef and chicken.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta \text{kWh} = \text{N/A}$$

Summer Peak Coincident Demand Savings

$$\Delta \text{kW} = \text{N/A}$$

Annual Gas Energy Savings

$$\Delta \text{therms} = \text{units} \times \frac{(\text{kBTU/h}_{\text{baseline}}\text{-kBTU/h}_{\text{ee}}) \times \text{cycle} \times \text{hrs}}{100}$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings
units = Number of infrared salamander broilers installed under the program
kBTU/h = Heating capacity input rating
baseline = Baseline condition or measure
ee = Energy efficient condition or measure
cycle = Broiler duty cycle
hrs = Operating hours per year
100 = Conversion factor (kBTU/therm), one therm equals 100 kBTU

Summary of Variables and Data Sources

Variable	Value	Notes
$\text{kBTU/h}_{\text{baseline}}$		From application, or use 38.5 as default[41]
$\text{kBTU/h}_{\text{ee}}$		From application

[41] Derived by taking the average rated salamander broiler from FSTC Commercial Cooking Appliance Technology Assessment, Table 4-3.

Variable	Value	Notes
cycle		From application, or use 0.7 as default[42]
hrs		From application, or use 2,496 as default[43]

Coincidence Factor (CF)

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

Baseline Efficiencies from which Energy Savings are Calculated

The baseline case for this measure is an existing natural gas salamander broiler without infrared burners.

Compliance Efficiency from which Incentives are Calculated

The compliance case is the installation of a natural gas salamander broiler with infrared burners.

Operating Hours

The annual operating hours for infrared salamander broilers will be site-specific and taken from the application. If unknown, the annual operating hours of infrared salamander broilers are assumed to be 2,496.[44]

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

More efficient food service equipment rejects less heat into the condition space than standard equipment, increasing space heating requirements while decreasing cooling load. However, no relevant studies have been performed to date that would allow quantification of these impacts. Until additional information is available, these impacts are excluded from the prescribed formulation of savings.

Ancillary Electric Savings Impacts

More efficient food service equipment rejects less heat into the condition space than standard equipment, increasing space heating requirements while decreasing cooling load. However, no relevant studies have been performed to date that would allow quantification of these impacts. Until additional information is available, these impacts are excluded from the prescribed formulation of savings.

[42] FSTC Commercial Cooking Appliance Technology Assessment, Table 4-3.
[43] Typical operating hours based on broiler operating schedule of 8 hours per day, 6 days per week, 52 weeks per year, provided in Food Service Technology Center Broiler Technical Assessment, Table 4.3
[44] Ibid

References

1. Food Service Technology Center, Commercial Cooking Appliance Technology Assessment, prepared for Enbridge Gas Distribution and Pacific Gas and Electric Company, by Fisher-Nickel Inc., 2002
Available from:
https://fishnick.com/equipment/techassessment/Appliance_Tech_Assessment.pdf

Record of Revision

Record of Revision Number	Issue Date
12-19-11	12/23/2019

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BUILDING SHELL

WINDOW - GLAZING

Measure Description

This measure covers the installation of high efficiency windows with reduced thermal conductance and solar heat gain coefficient. For the purposes of this measure, a window is defined as an assembled unit consisting of a frame/sash component holding one or more pieces of glazing functioning to admit light and/or air into an enclosure and designed for a vertical installation in an external wall of a commercial building.[45]

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \frac{SF}{100} \times (\Delta kWh/100\ SF) \times \frac{SEER_{baseline}}{SEER_{part}}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{SF}{100} \times (\Delta kW/100\ SF) \times \frac{EER_{baseline}}{EER_{part}} \times CF$$

Annual Gas Energy Savings

$$\Delta therms = units \times \frac{SF}{100} \times (\Delta kW/100\ SF) \times \frac{Eff_{baseline}}{Eff_{part}}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
SF	= Total glazing area of installed windows (ft^2)
(ΔkWh/100 SF)	= Annual electricity energy savings per 100 SF of window glazing area
(ΔkW/100 SF)	= Peak coincident demand electric savings per 100 SF of window glazing area
(Δtherms/100 SF)	= Annual gas energy savings per 100 SF of window glazing area
baseline	= Baseline condition or measure
part	= Participant
SEER	= Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
EER	= Energy efficiency ratio under peak conditions

[45] ENERGY STAR® Product Specification Residential Windows, Doors, and Skylights, Eligibility Criteria, V6.0, January 2014

Eff	=	Seasonal energy efficiency for fuel heating equipment
CF	=	Coincidence factor
100	=	Conversion from SF to 100 SF

Summary of Variables and Data Sources[46]

Variable	Value	Notes
SF		From application
(ΔkWh/100 SF)		Lookup from Appendix F based on Facility Type, City and HVAC System.
(ΔkW/100 SF)		Lookup from Appendix F based on Facility Type, City and HVAC System.
(Δtherms/100 SF)		Lookup from Appendix F based on Facility Type, City and HVAC System.
$EER_{baseline}$	11.2	EER used in the simulations[47]
EER_{part}		EER of cooling systems within participant population, defaults to $EER_{baseline}$ (no adjustment)
$SEER_{baseline}$	14	SEER used in the simulations[48]
$SEER_{part}$		SEER of cooling system within participant population, defaults to $SEER_{baseline}$ (no adjustment)
$Eff_{baseline}$	0.80	Efficiency (AFUE) used in the simulations[49]
Eff_{part}		Efficiency (AFUE, E_t, or E_c) of heating system within participant population, defaults to $Eff_{baseline}$ (no adjustment)
CF	NYC: 0.822 Rest of NY State: 0.477	

Unit energy and demand savings calculated from the building prototype simulation models are shown in Appendix F. The savings are tabulated by location, building type, and HVAC system type. Savings are derived from a baseline set by the assumed window and operating characteristics listed for each building prototype in Appendix A and using the compliance window characteristics below for the efficient case.

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is 0.822 for NYC and 0.477 throughout the rest of NY State.[50]

[46] Due to schedule of revisions, values specified here may not align with those presented throughout appendices.
[47] ECCCNYS 2016, Table C403.2.3(1) – Assumes a 5-ton packaged AC.
[48] Ibid.
[49] ECCCNYS 2016, Table C403.2.3(5) – Assumes a 150 kBTU/h gas boiler.
[50] C&I Unitary HVAC Load Shape Project Final Report, KEMA, 2011, Table 0-5: NY - Inland and NY - Urban/Coastal

Baseline Efficiencies from which Energy Savings are Calculated

The baseline is described by the assumed window and operating characteristics listed for each building prototype in Appendix A. Energy savings are estimated based on the characteristics of this baseline and an efficient case window as defined in the Compliance Efficiency section below.

Compliance Efficiency from which Incentives are Calculated

The minimum compliance condition for this measure is a window meeting the current ENERGY STAR® specifications. These specifications, which are used to derive savings prescribed by this measure, are listed below[51]:

U-Factor (BTU/h-ft^2-°F)	Solar Heat Gain Coefficient (SHGC)
≤0.27	Any
0.28	≥0.32
0.29	≥0.37
0.30	≥0.42

Operating Hours

The energy savings for windows are dependent on the HVAC system operating hours and thermostat set points. See Appendix A for the modeling assumptions for each building prototype.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. ENERGY STAR® Product Specification Residential Windows, Doors, and Skylights, Eligibility Criteria, Version 6.0, January 2014
   Available from:
   https://www.energystar.gov/sites/default/files/ES_Final_V6_Residential_WDS_Spec.pdf

[51] ENERGY STAR® Product Specification Residential Windows, Doors, and Skylights, Eligibility Criteria, V6.0, January 2014

2. ECCCNYS 2016, per IECC 2015; Table C403.2.3(1): Minimum Efficiency Requirements: Electrically Operated Unitary Air Conditioners And Condensing Units & Table C403.2.3(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers. Available from: https://codes.iccsafe.org/public/document/IECC2015NY-1/chapter-4-ce-commercial-energy-efficiency
3. Window properties for baseline windows taken from 2013 ASHRAE Handbook of Fundamentals Chapter 15. The 2013 ASHRAE Handbook of Fundamentals is used in the prototype simulations and therefore is not updated to the current version.
4. *C&I Unitary HVAC Load Shape Project Final Report*, KEMA, August 2, 2011, Table 0-5; (accessed March 21, 2017).
Available from:
http://www.neep.org/sites/default/files/resources/NEEP_HVAC_Load_Shape_Report_Final_August2.pdf

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6-17-9	6/30/2017
9-19-5	9/30/2019
12-19-12	12/23/2019

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

ELECTRONICALLY COMMUTATED (EC) MOTOR – HYDRONIC CIRCULATOR PUMPS

Measure Description

This measure covers the replacement of standard efficiency permanent split capacitor (PSC) motor circulator pumps with electronically commutated (EC) motor circulator pumps in HVAC hydronic and DHW systems. This measure is not applicable to systems used in industrial processes. A circulator pump is a specific type of pump used to circulate liquids in a closed distribution system. They are commonly found circulating water in a hydronic heating or cooling system.

Circulator pumps used in hydronic and DHW systems are typically electrically powered centrifugal pumps. For residential-rated equipment installed in commercial applications, use the residential measure entitled “Electronically Commutated (EC) Motor – Hydronic Circulator Pumps”.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \left(\frac{hp_{baseline}}{Eff_{baseline}} - \frac{hp_{ee}}{Eff_{ee}}\right) \times 0.746 \times hrs$$

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh = Annual electricity energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings
units = Number of measures installed under the program
baseline = Baseline condition or measure
ee = Energy efficient condition or measure
hp = Circulator motor horsepower
Eff = Efficiency
hrs = Annual hours of operation
CF = Coincidence factor
0.746 = Conversion factor (kW/hp), 746 watts equals one electric horsepower

Summary of Variables and Data Sources

Variable	Value	Notes
$hp_{baseline}$		From application. Defaults to hp_{ee}.
hp_{ee}		From application.
$Eff_{baseline}$	0.22	Baseline PSC pump efficiency (wire-to-water).[52]
Eff_{ee}	0.44	Efficient ECM pump efficiency (wire-to-water),[53] based on constant return water temperature control mode.
hrs	Continuous Heating: 3,504 Continuous Cooling: 2,208 On/Off Control Heating: From Application On/Off Control Cooling: From Application DHW: From application	From application; Continuous heating based on Assessment of New Energy Efficient Circulator Pump Technology.[54] Continuous cooling assumes three months (92 days) of 24-hour operation. On/Off control heating and cooling from application. If unknown, lookup based on location and facility type in Operating Hours section below. DHW from application. If unknown, lookup based on facility type in Operating Hours section below.
CF	Heating: N/A Continuous Cooling: 1.0 On/Off Control Cooling: 0.8 DHW: 1.0	

Coincidence Factor (CF)

The prescribed coincidence factor for continuous or on/off control heating is N/A.
The prescribed coincidence factor for continuous cooling is 1.0 and on/off control cooling is 0.8.[55]
The prescribed coincidence factor for DHW is 1.0. [56]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is circulator pump operating with a standard permanent split-capacitor (PSC) motor in a commercial or industrial heating, cooling and or DHW system.

[52] HPAC Magazine, Siegenthaler, John, "Higher efficiency circulators are here to stay", May 2017
[53] DOE, High-Performance Circulator Pump Demonstration, September 2018, p. 20
[54] Assessment of New Energy Efficient Circulator Pump Technology, pg 4-3. Assumed circulator pump is utilized 40% of the year (0.40 * 8,760 = 3,504)
[55] *No source specified – update pending availability and review of applicable references.*
[56] *No source specified – update pending availability and review of applicable references.*

Compliance Efficiency from which Incentives are Calculated

The compliance condition for this measure is a hydronic circulator pump operating with a high efficiency EC motor in a commercial or industrial heating and/or cooling system. High efficiency circulators may include better impeller design that will increase kWh savings, but these benefits are not considered in the prescribed savings estimation methodology.

Operating Hours

Annual circulator operating hours in a continuous operation hydronic heating system are assumed to be 3,504, based on assumed 40% utilization of circulator pump.

Annual circulator operating hours in a continuous operation hydronic cooling system are assumed to be 2,208, based on assumed 25% utilization of circulator pump.

On/Off control heating or cooling system operating hours shall come from application. If unknown, lookup in the table below based on location and facility type. Default HVAC system load hours were developed from NOAA hourly normals by assuming a 65ºF balance point temperature and summing dry bulb hours above the balance point for HVAC cooling and below the balance point for HVAC heating during building operating hours.[57] Operating hour assumptions for facility types are described in Appendix A.

Facility/System Type	Albany	Binghamton	Buffalo	Massena*	NYC	Poughkeepsie**	Syracuse
Assembly Cooling Hours	1,473	1,204	1,380	1,411	1,748	1,579	1,441
Assembly Heating Hours	3,181	3,445	3,284	3,263	2,908	3,092	3,227
Auto Repair Cooling Hours	1,405	1,170	1,309	1,341	1,639	1,475	1,369
Auto Repair Heating Hours	2,891	3,128	3,001	2,974	2,658	2,837	2,940
Big Box Retail Cooling Hours	1,317	1,105	1,218	1,252	1,520	1,360	1,274
Big Box Retail Heating Hours	2,622	2,837	2,733	2,706	2,417	2,594	2,675
Community College Cooling Hours	1,041	855	972	1,003	1,224	1,131	1,030
Community College Heating Hours	2,177	2,370	2,257	2,235	1,999	2,106	2,204
Dormitory Cooling Hours	1,761	1,309	1,722	1,587	2,863	2,327	1,672
Dormitory Heating Hours	6,784	7,292	6,801	6,978	5,735	6,257	6,872
Elementary School Cooling Hours	959	785	895	924	1,129	1,051	947
Elementary School Heating Hours	2,008	2,182	2,077	2,057	1,838	1,929	2,027
Fast Food Restaurant Cooling Hours	1,657	1,290	1,569	1,553	2,171	1,894	1,603

[57] NOAA National Centers for Environmental Information – NCEI 2010 Hourly Normals

Facility/System Type	Albany	Binghamton	Buffalo	Massena*	NYC	Poughkeepsie**	Syracuse
Fast Food Restaurant Heating Hours	4,412	4,789	4,504	4,537	3,918	4,204	4,475
Full-Service Restaurant Cooling Hours	1,594	1,275	1,511	1,493	1,982	1,720	1,526
Full-Service Restaurant Heating Hours	3,764	4,071	3,862	3,878	3,394	3,663	3,840
Grocery Cooling Hours	1,593	1,254	1,502	1,502	2,057	1,812	1,552
Grocery Heating Hours	4,119	4,474	4,219	4,238	3,673	3,929	4,176
High School Cooling Hours	1,041	855	972	1,003	1,224	1,131	1,030
High School Heating Hours	2,177	2,370	2,257	2,235	1,999	2,106	2,204
Hospital Cooling Hours	1,761	1,309	1,722	1,587	2,863	2,327	1,672
Hospital Heating Hours	6,784	7,292	6,801	6,978	5,735	6,257	6,872
Hotel Cooling Hours	1,761	1,309	1,722	1,587	2,863	2,327	1,672
Hotel Heating Hours	6,784	7,292	6,801	6,978	5,735	6,257	6,872
Large Office Cooling Hours	938	787	870	898	1,077	997	923
Large Office Heating Hours	1,820	1,980	1,902	1,877	1,685	1,777	1,847
Large Retail Cooling Hours	1,441	1,192	1,352	1,373	1,705	1,521	1,402
Large Retail Heating Hours	3,056	3,304	3,164	3,146	2,798	2,995	3,112
Light Industrial Cooling Hours	1,034	817	967	979	1,334	1,211	1,022
Light Industrial Heating Hours	2,634	2,878	2,708	2,714	2,349	2,482	2,659
Motel Cooling Hours	1,761	1,309	1,722	1,587	2,863	2,327	1,672
Motel Heating Hours	6,784	7,292	6,801	6,978	5,735	6,257	6,872
Religious Cooling Hours	849	720	771	800	951	864	819
Religious Heating Hours	1,506	1,639	1,590	1,567	1,395	1,499	1,540
Small Office Cooling Hours	829	694	771	795	956	891	818
Small Office Heating Hours	1,622	1,765	1,692	1,670	1,498	1,574	1,642
Small Retail Cooling Hours	1,368	1,139	1,275	1,299	1,604	1,421	1,321
Small Retail Heating Hours	2,823	3,052	2,933	2,915	2,590	2,788	2,884
University Cooling Hours	1,287	1,048	1,214	1,232	1,547	1,387	1,260

Facility/System Type	Albany	Binghamton	Buffalo	Massena*	NYC	Poughkeepsie**	Syracuse
University Heating Hours	2,850	3,089	2,940	2,928	2,600	2,772	2,897
Warehouse Cooling Hours	861	681	803	817	1,045	965	849
Warehouse Heating Hours	1,947	2,141	2,015	2,002	1,769	1,861	1,966

*Massena hourly normals are approximated from Rochester airport data due to limited available data
** Poughkeepsie hourly normals are approximated from Long Island ISLIP airport data due to limited available data

DHW circulator operating hours shall come from application. If unknown, lookup in the table below based on facility type. Operating hour assumptions for the prototypical building models are described in Appendix A.

Facility Type	Hours (hrs/yr)
Auto Repair	4,368
Big Box Retail	4,004
Community College	3,276
Dormitory	8,760
Elementary School	3,016
Fast Food Restaurant	6,188
Full-Service Restaurant	5,460
Grocery	5,824
High School	3,276
Hospital	8,760
Hotel	8,760
Large Office	2,808
Large Retail	4,576
Light Industrial	3,120
Motel	8,760
Religious	2,392
Small Office	2,808
Small Retail	4,264
University	4,212
Warehouse	2,860

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Higher efficiency circulators may lead to increased fossil fuel consumption in fuel heated buildings. Reduction in waste heat from increased efficiency in motors results in additional heating requirement. Reduction in waste heat from increased efficiency in motors also results in a reduced cooling requirement. These effects are not quantified in this methodology.

Ancillary Electric Savings Impacts

Higher efficiency circulators may lead to increased electric consumption in electrically heated buildings. Reduction in waste heat from increased efficiency in motors results in additional heating requirement. Reduction in waste heat from increased efficiency in motors also results in a reduced cooling requirement. These effects are not quantified in this methodology.

References

1. HPAC Magazine, Siegenthaler, John, "Higher efficiency circulators are here to stay", May 2017
   Available from: https://www.hpacmag.com/features/high-efficiency-circulators-brushless-dc-motors/#
2. DOE, High Performance Circulator Pump Demonstration, September 2018
   Available from: https://www.nrel.gov/docs/fy18osti/71705.pdf
3. Assessment of New Energy Efficient Circulator Pump Technology, Electric Power Research Institute, November 2010
   Available from: https://publicdownload.epri.com/PublicDownload.svc/product=000000000001020132/type=Product
4. NOAA National Centers for Environmental Information
   Available from: https://www.ncdc.noaa.gov/cdo-web/search?datasetid=NORMAL_HLY

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

KITCHEN DEMAND CONTROL VENTILATION (KDCV)

Measure Description

This measure covers the installation of kitchen demand control ventilation (KDCV). KDCV uses temperature sensors within the hood or hood exhaust collar and/or optic sensors within the hood to determine ventilation rate. These sensors, along with a microprocessor-based controller, control kitchen exhaust airflow and make-up air volume via VFDs. KDCV reduces ventilation and heating loads by controlling mechanical ventilation in response to cooking activities.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times hp \times (\Delta kWh/hp)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times hp \times (\Delta kW/hp) \times CF$$

Annual Gas Energy Savings

$$\Delta therms = units \times hp \times (\Delta therms/hp)$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings
units = Number of measures installed under the program
hp = Horsepower of exhaust fan
(ΔkWh/hp) = Annual electric energy savings (in kWh) per controlled motor horsepower
(ΔkW/hp) = Electric demand savings (in kW) per controlled motor horsepower
(Δtherms/hp) = Annual gas energy savings (in therms) per controlled motor horsepower
CF = Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
hp		From application.
(ΔkWh/hp)	4,423	SCE[58]
(ΔkW/hp)	0.612	SCE [59]

[58] Southern California Edison Work Paper SCE17CC008, Revision 0, pg xiii. The workpaper assumes that this value is applicable to all California climate zones. Therefore, the derivation of this value is independent of climate considerations and adjustments for New York weather data is not feasible.
[59] Ibid.

Variable	Value	Notes
(Δtherms/hp)		Look up based on location in Gas Savings table below.[60]
CF	0.9	

Gas Savings

Location	Δtherms/hp
Albany	268
Binghamton	288
Buffalo	266
Massena	328
NYC	189
Poughkeepsie	250
Syracuse	267

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.9.[61]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a kitchen exhaust hood fan with manual or automatic on/off control and constant volume exhaust fans.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a KDCV system using smoke and heat sensors to control the exhaust hood airflow and make-up air volume via variable frequency drive based on cooking activities. The compliance condition must comply with all applicable provisions of federal, state, local and municipal mechanical/ventilation and construction code including but not limited to sections C403.2.6 and C403.2.8 of ECCCNYS and NYCECC and sections 402 and 403 of NYS and NYC Mechanical Code (IMC).

Operating Hours

Operating hours are embedded into the per horsepower savings above using assumptions based on data collected from a representative population of 72 sites of varying type across the state of California. The average hours of use across all 72 sites used to derive per horsepower savings is 17 hours per day, and the average days per year is 350.

[60] Based on SCE Work Paper SCE17CC008 and NOAA Climate Normals. Baseline and climate dependent savings were established by assigning each California climate zone HDD values based on NOAA climate normals. The savings values from SCE Work Paper SCE17CC008 were then graphed against these HDD values. The associated trendline was then applied to New York's city specific HDD to develop location dependent savings values.
[61] Southern California Edison Work Paper SCE17CC008, Revision 0, pg xiii

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. Southern California Edison, Work Paper SCE17CC008 Exhaust Hoods Demand Controlled Ventilation, Revision 0, November 2017
   Available from: http://deeresources.net/workpapers
2. ECCCNYS 2016, per IECC 2015; 403.2.6 Ventilation and C403.2.8 Kitchen Exhaust Systems
   Available from: https://codes.iccsafe.org/content/IECC2015NY-1/chapter-4-ce-commercial-energy-efficiency
3. NYCECC 2016; C403.2.6 Ventilation and C403.2.8 Kitchen Exhaust Systems
   Available from: https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHC4.pdf&section=energy_code_2016
4. IMC NYS 2015; 402 Natural Ventilation and 403 Mechanical Ventilation
   Available from: https://codes.iccsafe.org/content/IMC2015NY/chapter-4-ventilation
5. IMC NYC 2015; 402 Natural Ventilation and 403 Mechanical Ventilation
   Available from: https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2014CC_MC_Chapter4_Ventilation.pdf&section=conscode_2014

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APPENDIX P

EFFECTIVE USEFUL LIFE (EUL)

SINGLE AND MULTI-FAMILY RESIDENTIAL MEASURES

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Appliance	Air Purifier	Residential	9	ENERGY STAR® Calc[62]
	Clothes Dryer	Residential	14	ENERGY STAR® M&I Scoping Report[63]
	Clothes Washer	Residential	11	DEER 2014 EUL ID: Appl-EffCW
	Dehumidifier	Residential	12	ENERGY STAR® Calc[64]
	Dishwasher	Residential	11	DEER 2014 EUL ID: Appl-EffDW
	Fireplace	Residential	15	DOE[65]
	Refrigerator and Freezer	Residential	14	DEER 2014 EUL ID: Appl-ESRefg
	Soundbar	Residential	7	RPP Product Analysis[66]
Appliance Control	Advanced Power Strip (APS)	Residential	8	DEER 2014 EUL ID: Plug-OccSens
Appliance Recycling	Air Conditioner - Room (RAC) Recycling	Residential	3	DEER 2014 EUL ID: HV-RAC-RUL
	Refrigerator Recycling	Residential	5	DEER 2014 EUL ID: Appl-RecRef
	Freezer Recycling	Residential	4	DEER 2014 EUL ID: Appl-RecFrzr

[62] Savings Calculator for ENERGY STAR® Qualified Appliances (last updated October 2016) Available from: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products
[63] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[64] ENERGY STAR® Dehumidifier Calculator https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
[65] Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products. Chapters 7 and 8. Department of Energy (DOE). January 30, 2015, pg 2-12 https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0002
[66] Retail Products Platform Product Analysis, Last Updated May 25, 2016. Available from: https://drive.google.com/file/d/0B9Fd3ckbKJp5OEpWSHg1eksyZ1U/view

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Building Shell	Air Conditioner – Room (RAC) Cover and Gap Sealer	Residential	5	See note below[67]
	Air Leakage Sealing	Residential	15	GDS[68]
	Insulation – Hot Water and Steam Pipe	Residential	15	GDS[69]
	Insulation – Opaque Shell	Residential	25	GDS[70]
	Storm Window	Residential	20	DOE[71]
	Window	Residential	20	DEER 2014 EUL ID: BS-Win
Domestic Hot Water	Heat Pump Water Heater (HPWH)	Residential	10	DEER 2014 EUL ID: WtrHt-HtPmp
	Indirect Water Heater	Residential	11	DEER 2014 EUL ID: WtrHt-Res-Gas
	Storage Water Heater - Gas	Residential	15	PA Consulting Group[72]
	Storage Water Heater - Electric	Residential	13	DEER 2014 EUL ID: WtrHt-Res-Elec
	Instantaneous Water Heater	Residential	20	DEER 2014 EUL ID: WtrHt-Instant-Res
Domestic Hot Water - Control	Drain Water Heat Recovery	Residential	30	2019 Title 24[73]
	Low-Flow – Faucet Aerator	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Low-Flow – Showerhead	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Thermostatic Shower Restriction Valve	Residential	10	UPC[74]

[67] At least one manufacturer's warranty period. www.gss-ee.com/products.html
[68] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures
[69] Ibid.
[70] Ibid.
[71] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22864rev2.pdf
[72] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report dated August 25, 2009. Available from: https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[73] 2019 Title 24, Part 6 CASE Report. "Drain Water Heat Recovery – Final Report." Available from: http://title24stakeholders.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_DWHR_Final_September-2017.pdf
[74] UPC certification under the International Association of Plumbing and Mechanical Officials standard IGC 244-2007a. A standard that includes a lifecycle test consisting of 10,000 cycles without fail. 10,000 cycles is the equivalent of three users showering daily for more than nine years.

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner – Central (CAC)	Residential	15	DEER 2014 EUL ID: HV-ResAC
	Air Conditioner – Room (RAC)	Residential	12	GDS[75]
	Air Conditioner – PTAC	Residential	15	DEER 2014 EUL ID: HVAC-PTAC
	Boiler, Hot Water – Steel Water Tube	Residential	24	ASHRAE Handbook, 2015
	Boiler, Hot Water – Steel Fire Tube	Residential	25	ASHRAE Handbook, 2015
	Boiler, Hot Water – Cast Iron	Residential	35	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Water Tube	Residential	30	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Fire Tube	Residential	25	ASHRAE Handbook, 2015
	Boiler, Steam – Cast Iron	Residential	30	ASHRAE Handbook, 2015
	Boiler and Furnace - Combination (“Combi”) Boiler	Residential	22	DOE[76]
	Boiler and Furnace - Combination (“Combi”) Furnace	Residential	20	DEER[77]
	Duct Sealing and Insulation	Residential	18	DEER 2014 EUL ID: HV-DuctSeal
	Electronically Commutated (EC) Motor – HVAC Blower Fan	Residential	15	DEER 2014 EUL ID: Motors-fan
	Electronically Commutated (EC) Motor – Hydronic Circulator Pump	Residential	15	DEER 2014 EUL ID: Motors-pump
	Furnace, Gas Fired	Residential	22	DOE[78,79]
	Heat Pump - Air Source (ASHP)	Residential	15	DEER 2014 EUL ID: HV-Res HP

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

[76] Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces, February 10, 2015, Table 8.2.17. Product definition of furnaces includes electric boilers with firing rates of less than 300,000 BTU/h
Available from: https://energy.mo.gov/sites/energy/files/technical-support-document---residential-furances_doe.pdf

[77] Based on DEER value for high efficiency boiler and instantaneous water heater

[78] U.S. DOE. “Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces” and “Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces.” August 30, 2016. Available from: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0217

[79] U.S. DOE. “Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces.” December 30, 2015. Available from: https://www.regulations.gov/document?D=EERE-2013-BT-STD-0021-0050

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Heat Pump – Ground Source (GSHP)	Residential	25	ASHRAE[80]
	Heat Pump – PTHP	Residential	15	DEER 2014 EUL ID: HVAC-PTHP
	Refrigerant Charge Correction & Tune-Up – Air Conditioner and Heat Pump	Residential	10	DEER 2014 EUL ID: HV-RefChrg
	Tune-Up - Boiler	Residential	5	DEER 2014 EUL ID: BlrTuneup
	Tune-Up - Furnace	Residential	5	DEER 2014 EUL ID: BlrTuneup
	Unit Heater, Gas Fired	Residential	13	ASHRAE Handbook, 2015
HVAC - Control	Outdoor Temperature Setback Control for Hydronic Boiler	Residential	EUL = RUL of Existing Boiler = Boiler EUL – (Current Year – Year of Mfr.)	N/A
	Steam Trap – Low Pressure Space Heating	Residential	6	DEER 2014 EUL ID: HVAC-StmTrp
	Submetering	Multifamily	10	NYSERDA[81]
	Thermostat – Programmable Setback Thermostat – Wi-Fi (Communicating) Thermostat – Learning	Residential	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve – One Pipe Steam Radiator	Multifamily	15	DOE[82]
	Smart Thermostatic Radiator Enclosure	Residential	15	DEER 2014 EUL ID: Motors-fan[83]

[80] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1
[81] NYSERDA Residential Electric Submetering Manual
[82] U.S. DOE, "Thermostatic Radiator Valve Evaluation", January 2015, Table 4. Cost-Benefit Financial Assumptions, pg. 16
[83] Based on assumed EUL of integrated fan, which is expected to be the first component to fail

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Lighting	LED Lamp	Residential	Rated Life listed by ENERGY STAR® or default to 15,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR® Lamps[84]
			50,000 hours	DLC[85]

[84] ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs) V2.1, June 2017, p. 19 (Capped at 20 years).
https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2.1%20Final%20Specification.pdf

[85] Placed on the Qualified Products List by the Design Light Consortium (DLC) 50,000 hours, according to the appropriate Application Category as specified in the DLC's Product Qualification Criteria, Technical Requirement Table version 4.4 or higher

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
Lighting	Light Fixture	LED (Interior)	Residential	Rated Life listed by ENERGY STAR or default to 25,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR® Fixtures[86]
		LED (Exterior)	Residential	Rated Life listed by ENERGY STAR or default to 35,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR® Fixtures
		LED (Inseparable)	Residential	Rated Life listed by ENERGY STAR or default to 50,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR® Fixtures
Lighting Control	Bi-Level Lighting		Multifamily Common Area	15	ComEd[87]

[86] ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, p. 18 (Capped at 20 years). https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

[87] ComEd Luminaire Level Lighting Control IPA Program Impact Evaluation Report prepared by Navigant Available from: http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY9_Evaluation_Reports_Final/ComEd_PY9_LLLC_IPA_Program_Impact_Evaluation_Report_2018-06-05_Final.pdf

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Motors and Drives	Pool Pump	Residential	10	DEER 2014 EUL ID: OutD-PoolPump
Other	Pool Heater	Residential	8	DOE[88]

[88] DOE, Chapter 8, Life-Cycle Cost and Payback Period Analyses, Table 8.75 Available from: https://www.regulations.gov/document?D=EERE-2006-STD-0129-0170

COMMERCIAL AND INDUSTRIAL MEASURES

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Agricultural Equipment - Control	Engine Block Heater Timer	C&I	8	See note below[89]
Appliance	Clothes Dryer	C&I	14	ENERGY STAR®M&I Report[90]
	Cooking Equipment[91]	C&I	12	DEER 2014 EUL IDs: Various
	Dishwasher	C&I	10 – Under Counter 15 – Single Door 20 – Conveyor Type 10 – Pots, Pans & Utensils	ENERGY STAR®Calc[92]
	Ice Maker	C&I	10	DEER 2014 EUL ID: Cook-IceMach
	Refrigerator and Freezer	C&I	12	DEER 2014 EUL ID: Cook-SDRef
Appliance - Control	Advanced Power Strip (APS)	C&I	8	DEER 2014 EUL ID: Plug-OccSens
	Vending Machine and Novelty Cooler Control	C&I	5	DEER 2014 EUL ID: Plug-VendCtrler
Appliance Recycling	Air Conditioner – Room (RAC)	C&I	9	DEER 2014 EUL ID: HV-RAC-ES
Building Shell	Cool Roof	C&I	15	DEER 2014 EUL ID: BldgEnv-CoolRoof
	Insulation - Hot Water and Steam Pipe	C&I	15	GDS[93]
	Insulation - Opaque Shell	C&I	30	ET & CEC[94]
	Window - Film	C&I	10	DEER 2014 EUL ID: GlazDaylt-WinFilm
	Window - Glazing	C&I	20	DEER 2014 EUL ID: BS-Win
Compressed Air	Air Compressor	C&I	13	Other State TRMs[95]
	Engineered Air Nozzle	C&I	15	Wisconsin PSC[96]

[89] Based on EUL's for similar control technology
[90] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[91] Applicable to all kitchen cooking equipment not otherwise listed
[92] ENERGY STAR® Savings Calculator for ENERGY STAR® Certified Commercial Kitchen Equipment www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx?5da4-3d90&5da4-3d90
[93] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures
[94] Energy Trust uses 30 years for commercial applications. CEC uses 30 years for insulation in Title 24 analysis.
[95] Based on a review of TRM assumptions from Ohio (August 2010), Massachusetts (October 2015), Illinois (February 2017) and Vermont (March 2015). Estimates range from 10 to 15 years.
[96] PA Consulting Group (2009). *Business Programs: Measure Life Study*. Prepared for State of Wisconsin Public Service Commission

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Compressed Air	No Air Loss Water Drain	C&I	13	MA Measure Life Study C&I Retrofit EUL[97]
	Refrigerated Air Dryer	C&I	13	Other State TRMs [98]
Domestic Hot Water (DHW)	Domestic Hot Water Tank Blanket	C&I	7	DEER
	Heat Pump Water Heater (HPWH)	C&I	10	DEER
	Indirect Water Heater	C&I	15	DEER 2014 EUL ID: WtrHt-Com
	Instantaneous Water Heater	C&I	20	DEER 2014 EUL ID: WtrHt-Instant-Com
	Storage Tank Water Heater	C&I	15	DEER 2014 EUL ID: WtrHt-Com
DHW - Control	Low-Flow – Faucet Aerator	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Low-Flow – Pre-Rinse Spray Valve (PRSV)	C&I	5	GDS
	Low-Flow – Salon Valve	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Low-Flow – Showerhead	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner – PTAC	C&I	15	DEER 2014 EUL ID: HVAC-PTAC
	Air Conditioner – Unitary	C&I	15	DEER 2014 EUL ID: HVAC-airAC
	Boiler and Furnace - Combination ("Combi") Boiler	C&I	22	DOE[99]
	Boiler and Furnace - Combination ("Combi") Furnace	C&I	20	DEER[100]
	Boiler, Hot Water – Steel Water Tube	C&I	24	ASHRAE Handbook, 2015
	Boiler, Hot Water – Steel Fire Tube	C&I	25	ASHRAE Handbook, 2015
	Boiler, Hot Water – Cast Iron	C&I	35	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Water Tube	C&I	30	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Fire Tube	C&I	25	ASHRAE Handbook, 2015
	Boiler, Steam – Cast Iron	C&I	30	ASHRAE Handbook, 2015
	Chiller – Air & Water Cooled	C&I	20	DEER 2014 EUL ID: HVAC-Chlr

[97] Measure Life Study prepared for The Massachusetts Joint Utilities, Energy & Resource Solutions, 2005 http://www.ers-inc.com/wp-content/uploads/2018/04/Measure-Life-Study_MA-Joint-Utilities_ERS.pdf
[98] Based on a review of TRM assumptions from Ohio (August 2010), Massachusetts (October 2015), Illinois (February 2017) and Vermont (March 2015). Estimates range from 10 to 15 years.
[99] Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces, February 10, 2015, Table 8.2.17
Available from: https://energy.mo.gov/sites/energy/files/technical-support-document---residential-furances_doe.pdf
[100] Based on DEER value for high efficiency boiler and instantaneous water heater

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Chiller – Cooling Tower	C&I	15	DEER 2014 EUL ID: HVAC-ClTwrPkgSys
	Condensing Unit Heater	C&I	18	Ecotope[101]
	Duct Sealing and Insulation	C&I	18	DEER 2014 EUL ID: HVAC-DuctSeal
	Electronically Commutated (EC) Motor - HVAC Blower Fan	C&I	15	DEER 2014 EUL ID: Motors-Fan
	Electronically Commutated (EC) Motor – Hydronic Circulator Pump	C&I	15	DEER 2014 EUL ID: Motors-pump
	Economizer –Dual Enthalpy Air Side	C&I	10	DEER 2014 EUL ID: HVAC-addEcono
	Furnace, Gas Fired	C&I	23	DOE[102], [103]
	Heat Pump – Unitary & Applied	C&I	15	DEER 2014 EUL ID: HVAC-airHP
	Heat Pump – PTHP	C&I	15	DEER 2014 EUL ID: HVAC-PTHP
	Heat Pump – Water Source (WSHP)	C&I	25	ASHRAE[104]
	Infrared Heater	C&I	17	GDS[105]
	Refrigerant Charge Correction & Tune Up – Air Conditioner and Heat Pump	C&I	10	DEER 2014 EUL ID: HVAC-RefChg
	Tune-Up - Boiler	C&I	5	DEER 2014 EUL ID: BlrTuneup
	Tune-Up – Chiller System	C&I	5	WI EUL DB[106]
	Variable Refrigerant Flow (VRF) System	C&I	15	DEER 2014 EUL ID: HVAC-VSD-pump
	Unit Heater, Gas Fired	C&I	13	ASHRAE Handbook, 2015

[101] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003)

[102] U.S. DOE. "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces" and "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces." August 30, 2016. Available from: https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0217

[103] U.S. DOE. "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces." December 30, 2015. Available from: https://www.regulations.gov/document?D=EERE-2013-BT-STD-0021-0050

[104] ASHRAE Owning and Operating Cost Database
Available from: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1

[105] GDS Associates, Inc. "Natural Gas Efficiency Potential Study." DTE Energy. July 29, 2016. Available from: https://www.michigan.gov/documents/mpsc/DTE_2016_NG_ee_potential_study_w_appendices_vFINAL_554360_7.pdf

[106] Wisconsin Public Service Commission: Equipment Useful Life Database, 2013
Excerpt available from: https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

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<tr><th>Category</th><th colspan="2">Commercial & Industrial Measures</th><th>Sector</th><th>EUL (years)</th><th>Source</th></tr>
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EUL ID: HVAC-EMS</td></tr>
<tr><td colspan="2">Demand Control Ventilation (DCV)</td><td>C&I</td><td>15</td><td>DEER 2014
EUL ID: HVAC-VSD-DCV</td></tr>
<tr><td colspan="2">Energy Management System</td><td>C&I</td><td>15</td><td>DEER 2014
EUL ID: HVAC-EMS</td></tr>
<tr><td colspan="2">Energy Management System – Guest Room</td><td>C&I</td><td>15</td><td>DEER 2014
EUL ID: HVAC-EMS</td></tr>
<tr><td colspan="2">Kitchen Demand Ventilation Control</td><td>C&I</td><td>15</td><td>PG&E[107]</td></tr>
<tr><td colspan="2">Outdoor Temperature Setback Control for Hydronic Boiler</td><td>C&I</td><td>EUL = RUL of Existing Boiler = Boiler EUL – (Current Year – Year of Mfr.)</td><td>N/A</td></tr>
<tr><td colspan="2">Steam Trap – Low-Pressure Space Heating</td><td>C&I</td><td>6</td><td>DEER 2014
EUL ID: HVAC-StmTrp</td></tr>
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EUL ID: HVAC-ProgTStats</td></tr>
<tr><td colspan="2">Thermostatic Radiator Valve</td><td>C&I</td><td>15</td><td>DOE[108]</td></tr>
<tr><td rowspan="2">Lighting</td><td rowspan="2">Light Fixture</td><td>LED Fixture (DLC)</td><td>C&I</td><td>50,000 hours /annual lighting operating hours or 15 yrs if annual operating hours are not known</td><td>DLC[109]</td></tr>
<tr><td>LED Fixture (Interior)</td><td>C&I</td><td>Rated Life listed by ENERGY STAR or default to 25,000 hours/annual lighting operating hours or 15 yrs if rated lifetime or annual operating hours are not known</td><td>ENERGY STAR®[110]</td></tr>
</table>

[107] PG&E Work Paper WPSDGENRCC0019, June 15, 2012

[108] U.S. DOE. “Thermostatic Radiator Valve Evaluation.” January 2015. Available from: https://www.nrel.gov/docs/fy15osti/63388.pdf

[109] 50,000 hours per L_{70} requirements prescribed by the DLC’s Product Qualification Criteria, Technical Requirement Table version 4.4

[110] Placed on the Qualified Fixture List by ENERGY STAR®, according to the appropriate luminaire classification as specified in the ENERGY STAR® Program requirements for Luminaires, version 2.1. Divided by estimated annual use, but capped at 20 years regardless (consistent with C&I redecoration and business type change patterns

Category	Commercial & Industrial Measures		Sector	EUL (years)	Source
Lighting	Light Fixture	LED Fixture (Exterior)	C&I	Rated Life listed by ENERGY STAR or default to 35,000 hours/annual lighting operating hours or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR®[111]
		LED Fixture (Inseparable)	C&I	Rated Life listed by ENERGY STAR or default to 50,000/annual lighting operating hours or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR®[112]
		LED Fixture (Uncertified)	C&I	Rated Life listed by ENERGY STAR or default to 25,000 hours /annual lighting operating hours or 15 yrs if rated lifetime or annual operating hours are not known	Uncertified
	LED Lamp		C&I	50,000 hours	DLC[113]
				Rated Life listed by ENERGY STAR or default to 15,000 hours /annual lighting operating hours or 15 yrs if rated lifetime or annual operating hours are not known	ENERGY STAR®
	Refrigerated Case LED		C&I	16	DEER 2014 EUL ID: GrocDisp-FixtLtg-LED

[111] Placed on the Qualified Fixture List by ENERGY STAR®, according to the appropriate luminaire classification as specified in the ENERGY STAR® Program requirements for Luminaires, version 2.1. Divided by estimated annual use, but capped at 20 years regardless (consistent with C&I redecoration and business type change patterns

[112] Placed on the Qualified Fixture List by ENERGY STAR®, according to the appropriate luminaire classification as specified in the ENERGY STAR® Program requirements for Luminaires, version 2.1. Divided by estimated annual use, but capped at 20 years regardless (consistent with C&I redecoration and business type change patterns

[113] Placed on the Qualified Products List by the Design Light Consortium (DLC) 50,000 hours, according to the appropriate Application Category as specified in the DLC's Product Qualification Criteria, Technical Requirement Table version 4.4 or higher

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting	Lighting Power Density (LPD)	C&I	15	GDS[114]
Lighting - Control	Bi-Level Lighting	C&I	15	ComEd[115]
	Integrated Interior Lighting Control	C&I	15	ComEd[116]
	Non-Integrated Interior Lighting Control	C&I	10	GDS[117]
	Plug-Load Occupancy Sensor	C&I	8	DEER[118]
Motors and Drives	Motor	C&I	15	DEER 2014 EUL ID: Motors-HiEff
	Variable Frequency Drive (VFD) – Fan and Pump	C&I	15	DEER 2014 EUL ID: HVAC-VSDSupFan
	Elevator Modernization	C&I	15	DEER 2014[119]
Other	Pool Heater	C&I	8	DOE[120]
Process Equipment	Steam Trap – Other Applications	C&I	6	DEER 2014 EUL ID: HVAC-StmTrp

[114] Measure Life Report, Residential and Commercial/Industrial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. As directed in the Interior and Exterior Lighting measure, new construction projects may be evaluated based on LPD. This value is provided for use with new construction LPD projects only.
Available from: https://energy.mo.gov/sites/energy/files/measure-life-report-2007.pdf

[115] ComEd Luminaire Level Lighting Control IPA Program Impact Evaluation Report prepared by Navigant
Available from:
http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY9_Evaluation_Reports_Final/ComEd_PY9_LLLC_IPA_Program_Impact_Evaluation_Report_2018-06-05_Final.pdf

[116] ComEd Luminaire Level Lighting Control IPA Program Impact Evaluation Report prepared by Navigant
Available from:
http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY9_Evaluation_Reports_Final/ComEd_PY9_LLLC_IPA_Program_Impact_Evaluation_Report_2018-06-05_Final.pdf

[117] Measure Life Report, Residential and Commercial/Industrial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.
Available from: https://energy.mo.gov/sites/energy/files/measure-life-report-2007.pdf

[118] DEER value for lighting occupancy sensors

[119] Assumes same EUL as VFD measure.

[120] DOE, Chapter 8, Life-Cycle Cost and Payback Period Analyses, Table 8.75 Available from:
https://www.regulations.gov/document?D=EERE-2006-STD-0129-0170

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Refrigeration	Air-Cooled Refrigeration Condenser	C&I	15	DEER 2014 EUL ID: GrocSys-Cndsr
	Automatic Door Closer for Walk-In Cooler/Freezer	C&I	8	DEER
	Cooler and Freezer Door Gasket	C&I	4	DEER 2014 EUL ID: GrocWlkIn-StripCrtn, GrocWlkIn-WDrGask
	Cooler and Freezer Door Strip	C&I	4	DEER 2014 EUL ID: GrocWlkIn-StripCrtn, GrocWlkIn-WDrGask
	Electronically Commutated (EC) Motor – Refrigerated Case or Walk-In Cooler/Freezer Evaporator Fan	C&I	15	DEER 2014 EUL ID: GrocDisp-FEvapFanMtr
	Equipment (Condenser, Compressor, and Sub-cooling)	C&I	15	DEER
	Evaporator Fan Motor – with Permanent Magnet Synchronous Motor (PMSM)	C&I	15	DEER 2014 EUL ID: GrocDisp-FEvapFanMtr
	Refrigerated Case Door	C&I	12	DEER 2014 EUL ID: GrocDisp-FixtDoors
	Refrigerated Case Night Cover	C&I	5	DEER 2014 EUL ID: GrocDisp-DispCvrs
Refrigeration - Control	Anti-Condensation Heater Control	C&I	12	DEER 2014 EUL ID: GrocDisp-ASH
	Condenser Pressure and Temperature Control	C&I	15	DEER
	Evaporator Fan Control	C&I	16	DEER 2014 EUL ID: Groc-WlkIn-WEvapFMtrCtrl

Record of Revision

Record of Revision Number	Issue Date
EUL's originally listed in July 18, 2011 Order	7/18/2011
Additional EUL's posted on web site	Subsequent to 7/18/2011 Order
7-13-28	7/31/2013
6-14-1	6/19/2014
6-14-2	6/19/2014
6-15-4	6/1/2015
6-16-2	6/30/2016
1-17-8	12/31/2016
6-17-16	6/30/2017
9-17-11	9/30/2017
12-17-17	12/31/2017

Record of Revision Number	Issue Date
3-18-21	3/31/2018
6-18-23	6/30/2018
9-18-21	9/30/2018
12-18-17	12/28/2018
3-19-16	3/29/2019
6-19-14	6/30/2019
9-19-10	9/30/2019
12-19-17	12/23/2019

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