Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
6-19-1	A	6/28/2019	6/28/2019	C/I Pneumatic System to Direct Digital Control (DCC) System Upgrade	New Measure Added	Pg. xx
6-19-2	A	6/28/2019	6/28/2019	C-I Automatic Door Closer for Walk-In Cooler/Freezer	New Measure Added	Pg. xx
6-19-3	A	6/28/2019	6/28/2019	C/I Evaporator Fan Motor – With Permanent Magnet Synchronous Motor (PMSM), for Refrigerated Case of Walk-In Cooler/Freezer	New Measure Added	Pg. xx
6-19-10	R	6/28/2019	6/28/2019	C/I Interior and Exterior Lighting	Updated Coincidence Factor for interior spaces	Pg. 434
6-19-12	R	6/28/2019	6/28/2019	C/I Cooler and Freezer Door Strip	Corrected Operating Hours lookup table values	Pg. 473
6-19-13	R	6/28/2019	6/28/2019	Appendix K	Added detail to health and multi-family building types	Pg. 696
6-19-14	R	6/28/2019	6/28/2019	Appendix P	Updated EUL entries for all measures contained in this Record of Revision	Pg. 765
6-19-15	R	6/28/2019	6/28/2019	Glossary	Added entries to align with all measures contained in this Record of Revision	Pg. 778

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between March 29, 2019 – June 28, 2019.

HEATING, VENTILATION AND AIR CONDITIONING (HVAC) – CONTROL

PNEUMATIC SYSTEM TO DIRECT DIGITAL CONTROL (DDC) SYSTEM UPGRADE

Measure Description

This measure covers the replacement of a pneumatic building HVAC control system with a new direct digital control (DDC) system. Pneumatic systems utilize compressed air as a medium of control for HVAC systems. DDC systems communicate electronically to achieve precise adjustments to the building HVAC system to maximize efficiency. The elimination of the air compressor and air dryer represent a significant improvement in load and demand reduction over the baseline condition.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{comp} + \Delta kWh_{dryer}$$

$$\Delta kWh_{comp} = units \times \{[LF_{comp} \times (1 + Air_{loss}) \times (ACFMr/100) \times (kW/100CFM) \times Cycle \times hrs] + [LF_{idle} \times (kW_{comp,\ Fan\ Motor} + kW_{comp,\ Compressor\ Motor}) \times (1 - Cycle) \times hrs]\}$$

$$\Delta kWh_{dryer} = units \times LF_{dryer} \times [(hp_{dryer,\ Fan\ Motor} \times 0.746/Eff_{dryer,\ Fan\ Motor}) + (hp_{dryer,\ Compressor\ Motor} \times 0.746/Eff_{dryer,\ Compressor\ Motor})] \times Cycle \times hrs$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \Delta kW_{comp} + \Delta kW_{dryer}$$

$$\Delta kW_{comp} = units \times LF_{comp} \times (ACFM/100) \times (1 + Air_{loss}) \times (kW/100CFM) \times CF$$

$$\Delta kW_{dryer} = units \times LF_{dryer} \times [(hp_{dryer,\ Fan\ Motor} \times 0.746/Eff_{dryer,\ Fan\ Motor}) + (hp_{dryer,\ Compressor\ Motor} \times 0.746/Eff_{dryer,\ Compressor\ Motor})] \times Cycle \times CF$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

Note: to determine specific power from existing air compressor if cut sheet is unavailable[1]

$$kW/100CFM = [(hp_{comp,\ Fan\ Motor} \times 0.746/Eff_{comp,\ Fan\ Motor}) + (hp_{comp,\ Compressor\ Motor} \times 0.746/Eff_{comp,\ Compressor\ Motor})]/(ACFM/100)$$

[1] How to Calculate Compressed Air Savings, Design World, January 2013

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
comp	= Property of air compressor
dryer	= Property of air dryer
Compressor Motor	= Property of compressor motor
Fan Motor	= Property of fan motor
idle	= Idle time
units	= Number of units removed under the program
LF	= Load factor
Air_{loss}	= Air loss percentage in the compressed air line
ACFMr	= Actual Cubic Feet per Minute required
kW/100CFM	= Specific Power
Cycle	= Percent of time the compressor is operating
hrs	= Annual hours of operation
kW	= Rated kilowatts
hp	= Horsepower
Eff	= Motor efficiency
ACFM	= Actual Cubic feet per Minute delivered by the air compressor
CF	= Coincidence factor
0.746	= Conversion Factor (1 bhp = 0.746 kW)
100	= Conversion factor, converts CFM to 100CFM

Summary of Variables and Data Sources

Variable	Value	Notes
LF_{comp}	0.80	Default Value[2]
LF_{dryer}	0.80	Default Value[3]
LF_{idle}	0.254	Default Value[4]
Air_{loss}	0.10	Default Value[5]
ACFMr		From Application
ACFM		From Application
kW/100CFM		From Application
Cycle	0.50	Default Value
Hrs		From Application
$kW_{comp, Fan Motor}$		From Application
$kW_{dryer, Compressor Motor}$		From Application
$hp_{dryer, Fan Motor}$		From Application
$hp_{dryer, Compressor Motor}$		From Application
$hp_{comp, Fan Motor}$		From Application

[2] CAGI's Compressed Air and Gas Handbook, Chapter 4, Table 4.4
[3] Ibid
[4] How to Calculate Compressed Air Savings, Design World, January 2013. *Average % of Total Package kW Zero Flow (Idle) against Total Package kW Full Flow in Figure 3*
[5] CAGI's Technical Briefing: Sizing Compressed Air Equipment

Variable	Value	Notes
$hp_{comp,\ Compressor\ Motor}$		From Application
$Eff_{dryer,\ Fan\ Motor}$		From Application
$Eff_{dryer,\ Compressor\ Motor}$		From Application
$Eff_{comp,\ Fan\ Motor}$		From Application
$Eff_{comp,\ Compressor\ Motor}$		From Application
CF	0.8	

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.8.[6]

Baseline Efficiencies from which Energy Savings are calculated

The baseline condition is an existing operational pneumatic building HVAC control system with an air compressor and a refrigerated air dryer. If the existing system does not include a refrigerated air dryer, the savings associated with the air dryer must be set equal to zero. The existing compressor can be a single or multi stage reciprocating, rotary screw or variable displacement compressor with load/unload controls and blow down capability.

Compliance Efficiency from which Incentives are calculated

The compliance condition is a building HVAC control system using DDC technology.

Operating Hours

The operating hours should reflect the building HVAC system operating hours and shall be defined by the application.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

[6] *No source specified – update pending availability and review of applicable references.*

References

1. How to Calculate Compressed Air Savings, by Ron Marshall for Design World Online, January 12, 2013
   Available from: https://www.designworldonline.com/how-to-calculate-compressed-air-savings/
2. CAGI's Compressed Air and Gas Handbook, Chapter 4
   Available from: https://www.cagi.org/pdfs/cagi_electhb_ch4.pdf

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REFRIGERATION

AUTOMATIC DOOR CLOSER FOR WALK-IN COOLER/FREEZER

Measure Description

This measure covers the installation of an auto-closer to the main insulated opaque door(s) of an existing walk-in cooler or freezer. Auto-closers on walk-in coolers and freezers can reduce the amount of time that doors are open, thereby reducing infiltration and refrigeration loads. The auto-closer must firmly close the door when it is within 1-inch of full closure. The walk-in door perimeter must be ≥ 16 ft.[1]

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of doors equipped with automatic door closers installed under the program
(ΔkWh/unit)	= Annual electric energy savings per door equipped with an automatic door closer
(ΔkW/unit)	= Peak coincident demand electric savings per door equipped with an automatic door closer

[1] Lower limit of eligible door size based on Cadmus Group, Inc., *"Energy Smart Grocer Impact Evaluation"*, October 21, 2013.

Summary of Variables and Data Sources

Variable	Value	Notes
(ΔkWh/unit)		Lookup based on location in table below.[2]
(ΔkW/unit)		Lookup based on location in table below.[3]

Per Unit Savings Lookup Table

Location	Cooler Savings (ΔkWh/unit)	Cooler Savings (ΔkW/unit)	Freezer Savings (ΔkWh/unit)	Freezer Savings (ΔkW/unit)
Albany	1,860	0.570	3,469	0.778
Binghamton	1,822	0.550	3,398	0.735
Buffalo	1,851	0.565	3,451	0.768
Massena	1,819	0.549	3,392	0.731
New York City	1,959	0.621	3,653	0.891
Poughkeepsie	1,873	0.576	3,493	0.793
Syracuse	1,855	0.567	3,460	0.773

Coincidence Factor (CF)

The prescribed value for the coincidence factor is N/A. Peak coincidence is embedded into kW per unit savings above.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is an existing walk in cooler or freezer without an existing auto-closer or strip curtains.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a walk-in cooler or freezer with an automatic, spring-loaded or hydraulic-type door closer installed. The walk-in door perimeter must be ≥ 16 ft.

Operating Hours

Operating hours are embedded into the PG&E energy models used to estimate the energy savings listed above.

Effective Useful Life (EUL)

See Appendix P.

[2] Based on PG&E Work Paper PGECOREF110 and NOAA Climate Normals. Baseline and climate dependent savings were established by comparing savings values from PG&E Work Paper PGECOREF110 against respective California climate zone NOAA climate normal CDD_{65} values. The established trendline was then applied to New York's city specific CDD values to develop New York savings.
[3] Ibid

Ancillary Fossil Fuel Savings Impacts

Reduction in heat transfer between the refrigerated case and ambient air during periods when the main door is open will result in a negligible reduction in space heating requirements and a small increase in cooling requirements. Consideration of these effects is not included in this methodology.

Ancillary Electric Savings Impacts

Reduction in heat transfer between the refrigerated case and ambient air during periods when the main door is open will result in a negligible reduction in space heating requirements and a small increase in cooling requirements. Consideration of these effects is not included in this methodology.

References

1. Pacific Gas & Electric Company. Work Paper PGECOREF110 Refrigerated Storage Auto Closer Revision 7, June 14, 2018
   Available from: www.deeresources.net/workpapers
2. Cadmus Group, Inc., *"Energy Smart Grocer Impact Evaluation"*, October 21, 2013. Prepared for Bonneville Power Administration.
   Available from: https://www.bpa.gov/EE/Utility/Evaluation/Evaluation/Cadmus_ESG_Impact_Evaluation_Report_Final.pdf
3. NOAA National Centers for Environmental Information – NCEI 1981-2010 Climate Normals
   Available from: https://www.ncdc.noaa.gov/cdo-web/datatools/normals

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REFRIGERATION

EVAPORATOR FAN MOTOR – WITH PERMANENT MAGNET SYNCHRONOUS MOTOR (PMSM), FOR REFRIGERATED CASE OR WALK-IN COOLER/FREEZER

Measure Description

This measure covers the replacement of shaded pole (SP), permanent split capacitor (PSC), or electrically commutated (EC) evaporator fan motors with permanent magnet synchronous motors (PMSM) in commercial refrigeration equipment. PMSMs provide increased efficiency over other motors requiring less energy to operate and introducing less heat into the refrigerated case, which reduces the total refrigeration load.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{W_{ee}}{1{,}000} \times \left(\frac{1}{Eff_{baseline}} - \frac{1}{Eff_{ee}}\right) \times \left(1 + \frac{1}{COP_{ref}}\right) \times hrs$$

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric 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
W	= Rated motor wattage
Eff	= Motor efficiency
COP_{ref}	= Coefficient of performance of refrigerator compressor
hrs	= Annual operating hours
CF	= Coincidence Factor
1,000	= Conversion factor, one kW equals 1,000 W

Summary of Variables and Data Sources

Variable	Value	Notes
W_{ee}		From application.
$Eff_{baseline}$	Shaded Pole: 0.20 PSC: 0.29 EC: 0.66	For replacement of motors in reach-in cases, look up based on existing motor type.[1] For new construction, unknown existing conditions and walk-in coolers and freezers, use value associated with EC motors.
Eff_{ee}	0.73	Oak Ridge National Laboratory[2]
COP_{ref}	Cooler: 3.03 Freezer: 1.66	From application; COP = 3.517/(kW/ton), where kW/ton is the rated efficiency of the compressor in input kW per ton of refrigeration capacity. If unknown, use default values provided.[3]
hrs	Reach-in Case: 8,500 Walk-in Cooler Control: 5,600 Walk-in No Cooler Control: 8,760	Based on experience of National Resource Management, Inc (NRM) and metered data from multiple installations of NRM proprietary refrigeration control system.[4]
CF	1.0	

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 1.0.[5]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition for walk-in coolers or freezers manufactured on or after January 1, 2009 is an EC motor[6] with full load efficiency as prescribed by federal energy conservation standards for electric motors in 10 CFR 431.446 and 10 CFR 431.25, as applicable. The baseline condition for walk-in coolers or freezers manufactured before January 1, 2009 and reach-in refrigerated display cases is equivalent to the equipment being replaced (shaded pole or PSC motor). Baseline equipment shall be assumed to be of equivalent speed and horsepower to the efficient case.

[1] U.S. DOE, Technical Support Document Commercial Refrigeration Equipment, Chapter 5, Table 5.6.4: Details for Evaporator Fan Motor Design Option

[2] ORNL, Q-Sync Motors in Commercial Refrigeration: Preliminary Test Results and Projected Benefits, p 5

[3] Based on CDH Energy evaluation of actual refrigeration system performance for several commercially available compressors, dated 09/06/2017. Values presented reflect average efficiencies of systems using R-22, which was the most common refrigerant in active refrigeration systems in 2008 (per Analysis of Equipment and Practices in the Reclamation Industry, October 2010).

[4] REVIEW OF UNDERLYING REFERENCE PENDING: Cooler Control Measure Impact Spreadsheet User's Manual, Select Energy Services, Inc., March 2004

[5] *No source specified – update pending availability and review of applicable references.*

[6] 10 CFR 431.306

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a PMSM installed in a commercial refrigerated reach-in display case or walk-in cooler/freezer with full-load efficiency exceeding that prescribed by federal energy conservation standards for electric motors in 10 CFR 431.446 or 10 CFR 431.25, as applicable.

Operating Hours

The annual operating hours for a refrigerated display case motor are 8,500. The annual operating hours of a walk-in cooler or freezer evaporator fan motor is 8,760 when a cooler control system is not a component of the efficient system and 5,600 otherwise.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

Reduction in evaporator fan power reduces waste heat that must be displaced by the compressor. The refrigeration savings are addressed in the prescribed energy savings calculation methodology.

References

1. 10 CFR 431.306 Energy conservations standards and their effective dates
   Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=bf918c7935d524eeb5d031252bb66fba&mc=true&node=pt10.3.431&rgn=div5#se10.3.431_1306
2. Department of Energy; Technical Support Document Commercial Refrigeration Equipment, Chapter 5: Engineering Analysis, August 2013
   Available from:
   https://www1.eere.energy.gov/buildings/appliance_standards/pdfs/cre2_nopr_tsd_2013_08_28.pdf
3. Oak Ridge National Laboratory, Q-Sync Motors in Commercial Refrigeration: Preliminary Test Results and Projected Benefits
   Available from: https://info.ornl.gov/sites/publications/files/Pub58600.pdf
4. *Cooler Control Measure Impact Spreadsheet Users' Manual*, Select Energy Services, Inc. for NSTAR, March 9, 2004
5. Analysis of Equipment and Practices in the Reclamation Industry
   Available from: https://www.epa.gov/sites/production/files/2015-08/documents/analysis_of_equipment_and_practices_in_the_reclamation_industry.pdf
6. 10 CFR 431.446 Small electric motors energy conservation standards and their effective dates
   Available from: https://www.ecfr.gov/cgi-bin/textidx?SID=f7f8d64bb400ae3dc2d13f131cf116bb&mc=true&node=pt10.3.431&rgn=div5#se10.3.431_1446

7. 10 CFR 431.25 Energy conservation standards and effective dates
   Available from: https://www.ecfr.gov/cgi-bin/textidx?SID=070fc8cd95943842a1e7a6f793d73496&mc=true&node=pt10.3.431&rgn=div5#se10.3.431_125

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LIGHTING

INTERIOR AND EXTERIOR LIGHTING

Measure Description

This section covers energy-efficient lighting equipment, such as energy-efficient lamps, energy-efficient ballasts, compact fluorescent lamps, LED lamps, and improved lighting fixtures. Improved lighting fixtures may include reflectors and other optical improvements to lighting fixtures. These technologies, taken separately or combined into an energy-efficient lighting fixture, provide the required illumination at reduced input power.

Per EISA 2007, effective beginning January 1, 2020, if more stringent regulations are not put into effect by that date, the sale of general service lamps that do not meet a minimum efficiency standard of 45 lumens per watt will be prohibited.[1] Although baseline conditions for this measure are assumed to be the existing lighting wattage, this stipulation may still have a significant impact on estimated energy savings associated with replacement of general service lamps (20% - 70% depending on lumen output) beginning in 2020, particularly in cases where building code is triggered (new construction or renovations). This information is provided to inform future ETIP development.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

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

[1] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 89

Annual Electric Energy Savings

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

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = area \times \left[\frac{LPD_{baseline} - LPD_{ee}}{1{,}000}\right] \times hrs_{operating} \times HVAC_g$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures
CF	= Coincidence factor
$_{ee}$	= Energy efficient condition or measure
$_{baseline}$	= Baseline condition or measure
area	= Extent of space or surface
1,000	= Conversion factor, one kW equals 1,000 watts
LPD	= Lighting power density
W	= Watts
$hrs_{operating}$	= Lighting operating hours
$HVAC_c$	= 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
$units_{baseline}$		Number of baseline measures, from application. Set equal to $Units_{ee}$ if unknown.
$units_{ee}$		Number of energy efficient measures installed under the program, from application.
$W_{baseline}$		Connected load of the baseline unit(s) displaced, from application (in Watts).
W_{ee}		Connected load of the energy-efficient unit, from application (in Watts).
$hrs_{operating}$		Lighting operating hours. From application or default,

Variable	Value	Notes
		as listed below in the Operating Hours table.
$LPD_{baseline}$		Lighting power density (in W/ft^2) for baseline measure, from application, based on NYS/NYC Energy Conservation code. New construction or major renovation (as defined by applicable code/permits) only.
LPD_{ee}		Lighting power density (in W/ft^2) for energy efficient measure, from application, based on installed system design. New construction or major renovation (as defined by applicable code/permits) only.
area		Floor area illuminated by lighting system (in ft^2)
$HVAC_c$	Exterior and Unconditioned Space: 0	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	Exterior and Unconditioned Space: 0	HVAC interaction factor for peak demand at utility summer peak hour (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_g$	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: 1.0 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. The building types for the HVAC interactive effect factors by facility type are shown in the lighting Operating Hours table below.

Coincidence Factor (CF)

The prescribed coincidence factor for commercial indoor lighting measures is 1.0.[2] Since exterior lighting is generally off during daylight hours, the coincidence factor for exterior lighting is 0.0.

[2] *No source specified – update pending availability and review of applicable references.*

Baseline Efficiencies from which Energy Savings are Calculated

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

Code LPD shall be taken from chapter C405.4: Interior Lighting Power Requirements (Prescriptive) and chapter 405.5: Exterior Lighting (Mandatory) of the Energy Conservation Construction Code of New York State[3] (ECCCNYS) and the New York City Energy Conservation Code[4] (NYCECC) that are based on IECC 2015. Alternatively, ASHRAE Standard 90.1-2013 may be referenced for compliance. In both cases, either the Building Area or Space-By-Space compliance path may be used.

Compliance Efficiency from which Incentives are Calculated

Compliance efficiency and fixture/lamp specifications shall be dictated by program eligibility criteria. See table of standard fixture wattages in Appendix C. Manufacturers' cut sheets may substitute for the standard fixture watts in Appendix C if available. In new construction or major renovation projects, the new lighting system power consumption should be expressed as a lighting power density (LPD) in watts per square foot.

Operating Hours

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

Facility Type	Lighting Hours (hrs/yr)	HVAC Int	Facility Type	Lighting Hours (hrs/yr)	HVAC Int
Auto Related[1]	2,810	AR	Manufacturing Facility	2,857	Ind
Automotive / Transportation Service or Repair Facility (24/7)	8,760	AR	Medical Offices	3,748	SOfc
Bakery	2,854	FS	Motion Picture Theatre	1,954	Asy
Banks	3,748	SOfc	Multi-Family (Common Areas)	7,665	MFL
Church	1,955	Rel	Museum	3,748	Asy
College– Cafeteria[2]	2,713	FS	Nursing Homes	5,840	MFL

[3] ECCCNYS 2016; C405.4: Interior Lighting Power Requirements (Prescriptive) & C405.5: Exterior Lighting Power (Mandatory)
[4] NYCECC 2016; C405.4: Interior Lighting Power Requirements (Prescriptive) & C405.5: Exterior Lighting Power (Mandatory)

Facility Type	Lighting Hours (hrs/yr)	HVAC Int	Facility Type	Lighting Hours (hrs/yr)	HVAC Int
College – Classes	2,586	CC	Office (General Office Types)[2]	3,013	SOfc/ LOfc
College - Dormitory	3,066	Dorm	Parking Garages	4,368	None
Commercial Condos[3]	3,100	SOfc	Parking Garages (24/7)	7,717	None
Convenience Stores	6,376	SRet	Parking Lots	4,100	None
Convention Center	1,954	Asy	Penitentiary	5,477	MFL
Court House	3,748	LOfc	Performing Arts Theatre	2,586	Asy
Dining: Bar Lounge/Leisure	4,182	FS	Police / Fire Stations (24 Hr)	7,665	Asy
Dining: Cafeteria / Fast Food	6,456	FF	Post Office	3,748	SRet
Dining: Family	4,182	FS	Pump Stations	1,949	Ind
Entertainment	1,952	Asy	Refrigerated Warehouse	2,602	RWH
Exercise Center	5,836	SRet	Religious Building	1,955	Rel
Fast Food Restaurants	6,376	FF	Restaurants	4,182	FS
Fire Station (Unmanned)	1,953	Asy	Retail	3,463	SRet/ LRet
Food Stores	4,055	Gro	School / University	2,187	Univ
Gymnasium	2,586	Asy	Schools (Jr./Sr. High)	2,187	HS
Hospitals	7,674	Hosp	Schools (Preschool/Elementary)	2,187	Sch
Hospitals / Health Care	7,666	Hosp	Schools (Technical/Vocational)	2,187	CC
Industrial - 1 Shift	2,857	Ind	Small Services	3,750	SOfc
Industrial - 2 Shift	4,730	Ind	Sports Arena	1,954	Asy
Industrial - 3 Shift	6,631	Ind	Town Hall	3,748	Asy
Laundromats	4,056	SRet	Transportation	6,456	Asy
Library	3,748	LOfc	Warehouse (Not Refrigerated)	2,602	WH
Light Manufacturers[2]	2,613	Ind	Waste Water Treatment Plant	6,631	Ind
Lodging (Hotels/Motels)	3,064	Hotel/ Motel	Workshop	3,750	Ind
Mall Concourse	4,833	LRet			

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

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. ECCCNYS 2016, per IECC 2015; Chapter C404.4: Interior Lighting Power Requirements (Prescriptive) & C405.5: Exterior Lighting Power (Mandatory)
   Available from: https://codes.iccsafe.org/public/document/IECC2015NY-1/chapter-4-ce-commercial-energy-efficiency
2. NYCECC 2016: Chapter C404.4: Interior Lighting Power Requirements (Prescriptive) & C405.5: Exterior Lighting Power (Mandatory)
   Available from: https://www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page
3. Lighting operating hour data taken from the CL&P and UI Program Savings Documentation for 2008 Program Year, with exceptions as noted.
   Available from:
   https://library.cee1.org/system/files/library/8821/CEE_Eval_2008ProgramSavingsDocumentPSD_1Jan2008.pdf
4. Additional lighting operating hour data taken from 2008 DEER Update – Summary of Measure Energy Analysis Revisions, August, 2008
   Available from: www.deeresources.com
5. Small Business Direct Install Program Evaluation Review, Prepared for the New York State Department of Public Service-E^2 Working Group, by the Small Commercial EM&V Review subcommittee, April 3, 2015
   Available from:
   https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/96006876d01739b785257c85005a58e3/$FILE/ATTGYZRG.pdf/SBDI%20EMV%20studies%20-%20Final%20Report%20-%202015-01-30.pdf

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Record of Revision Number	Issue Date
1	10/15/2010
6-15-4	6/1/2015
1-16-6	12/31/2015
9-17-5	9/30/2017
6-19-10	6/28/2019

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REFRIGERATION

COOLER AND FREEZER DOOR STRIP

Measure Description

This measure covers the repair or replacement of existing damaged or missing strip curtains on walk-in freezers and coolers with a chilled storage area of less than 3,000ft^2.[1] Strip curtains on both walk-in freezers (≤ 32°F) and walk-in coolers (> 32°F and ≤ 55°F) serve to prevent air infiltration during periods when the main door is open for routine stocking activity. When damaged or missing, the warmer, more humid air present in the store will infiltrate the unit, increasing the load of the refrigeration system and often reducing the efficiency of the evaporator unit as frost accumulates, impairing its effectiveness. This measure applies to strip curtains on the main door of walk-in units typical of supermarkets, convenience stores and restaurants.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = ft^2{}_{door} \times (\Delta kWh/ft^2)_{door}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = ft^2{}_{door} \times \frac{(\Delta kWh/ft^2)_{door}}{hrs} \times \text{CF}$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings
$ft^2{}_{door}$ = Area of cooler or freezer door opening, in square feet
$(\Delta kWh/ft^2)_{door}$ = Annual electric energy savings per square foot of door opening
hrs = Annual cooler or freezer operating hours per year
CF = Coincidence Factor

Summary of Variables and Data Sources

Variable	Value	Notes
$ft^2{}_{door}$		From application.
$(\Delta kWh/ft^2)_{door}$		Look up in Deemed Savings table below based on case type and application.

[1] 10 CFR 431.302

Variable	Value	Notes
hrs		Lookup from table in Operating Hours section below based on case type and application.
CF	1.0	

Deemed Savings ($\Delta kWh/ft^2$)$_{door}$[2]

Case Type	Application	$\Delta kWh/ft^2$
Cooler (> 32°F)	Supermarket	159
	Restaurant	18
	Convenience Store	14
Freezer (≤ 32 °F)	Supermarket	409
	Restaurant	77
	Convenience Store	16

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is 1.0[3]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition efficiency is a walk-in cooler or freezer door with damaged or missing strip curtains in excess of 15% of the door area.[4]

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a walk-in cooler or freezer with repaired or replaced strip curtains covering the entire open door area.

[2] ADM Associates, Inc. Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation, Table 6-3, p. 6-6.

[3] *No source specified – update pending availability and review of applicable references.*

[4] ADM Associates, Inc. Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation, p. 6-10

Operating Hours

Annual hours during which the door is open and strip curtains are therefore preventing heat exchange between the refrigerated case and ambient air is used to determine an estimate of associated demand savings. Prescribed annual hours for formulation of demand savings are provided in the table below.[5]

Case Type	Application	hrs
Cooler (> 32°F)	Supermarket	803
	Restaurant	274
	Convenience Store	231
Freezer (≤ 32 °F)	Supermarket	621
	Restaurant	231
	Convenience Store	55

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in heat transfer between the refrigerated case and ambient air during periods when the main door is open will result in a small reduction in space heating requirements and a small increase in cooling requirements. This impact is negligible and is not considered in this methodology.

Ancillary Electric Savings Impacts

Reduction in heat transfer between the refrigerated case and ambient air during periods when the main door is open will result in a small reduction in space heating requirements and a small increase in cooling requirements. This impact is negligible and is not considered in this methodology.

References

1. 10 CFR 431.302 Definitions concerning walk-in coolers and walk-in freezers. Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=863517ec5f69fb78dad68864aa84c128&mc=true&n=pt10.3.431&r=PART&ty=HTML#se10.3.431_1302
2. ADM Associates, Inc. "Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation," California Public Utilities Commission Energy Division, February 18, 2010. Available from: http://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf

[5] ADM Associates, Inc. Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation, Table 6-5, p. 6-10

Record of Revision

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1-16-16	12/31/2015
3-18-16	3/29/2018
6-19-12	6/28/2019

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APPENDIX K

VARIABLE FREQUENCY DRIVES

Unit energy (kWh) savings for VFDs were estimated by building type, HVAC type and city using DOE-2.2 simulations of the prototype buildings with built-up HVAC systems. The simulations were run for each of the three built-up system types (CV no economizer, CV with economizer, and VAV with economizer) and the results were weighted according to the HVAC system weights shown in Appendix B. The results for each prototype are shown by measure and location below:

Community College

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	606	683	497	429	452	216
Binghamton	716	682	496	510	534	256
Buffalo	663	631	460	471	495	237
Massena	553	835	383	390	412	197
NYC	419	399	290	293	312	150
Poughkeepsie	464	441	321	325	346	165
Syracuse	539	513	373	380	402	193

Dormitory

Climate	Measure Unit Savings (kWh/hp)			
	CW Pump	CHW Pump	HW Pump	Tower Fan
Albany	961	453	386	190
Binghamton	963	453	386	143
Buffalo	964	453	386	152
Massena	966	451	388	166
NYC	965	453	393	266
Poughkeepsie	962	450	387	244
Syracuse	966	452	388	204

High School

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	350	232	60	513	674	203
Binghamton	359	234	58	509	661	169
Buffalo	358	233	53	511	660	176
Massena	357	238	65	518	663	187
NYC	327	231	44	531	707	241
Poughkeepsie	348	232	54	522	699	209
Syracuse	346	236	59	527	692	210

Hospital

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	2,053	1,665	1,142	1,645	1,860	413
Binghamton	2,053	1,687	1,142	1,549	1,681	380
Buffalo	2,053	1,678	1,142	1,591	1,731	416
Massena	2,053	1,689	1,142	1,537	1,588	395
NYC	2,053	1,713	1,142	1,801	2,137	574
Poughkeepsie	2,053	1,718	1,142	1,694	1,977	487
Syracuse	2,053	1,671	1,142	1,618	1,796	415

Hotel

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	73	1,740	6,559	326	250	1,571
Binghamton	73	1,745	6,554	284	211	1,423
Buffalo	75	1,764	6,551	321	247	1,583
Massena	72	1,802	6,499	284	188	1,377
NYC	75	1,925	6,603	332	242	1,525
Poughkeepsie	73	2,198	6,563	286	201	1,475
Syracuse	74	1,854	6,556	295	209	1,497

Large Retail

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	1,049	3,421	3,287	1,085	1,282	280
Binghamton	1,059	3,481	3,241	1,074	1,266	217
Buffalo	1,062	3,462	3,270	1,082	1,272	240
Massena	1,053	3,448	3,246	1,080	1,257	251
NYC	1,020	3,310	3,411	1,091	1,310	396
Poughkeepsie	1,036	3,385	3,361	1,093	1,306	341
Syracuse	1,054	3,429	3,298	1,089	1,289	296

Office

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	1,334	1,231	981	1,286	1,646	269
Binghamton	1,315	1,195	905	1,156	1,463	233
Buffalo	1,299	1,196	938	1,154	1,467	255
Massena	1,382	1,258	981	1,315	1,625	248
NYC	1,183	1,176	845	1,258	1,605	407
Poughkeepsie	1,208	1,165	742	1,240	1,606	344
Syracuse	1,295	1,213	1,005	1,236	1,578	292

University

Climate	Measure Unit Savings (kWh/hp)					
	CW Pump	CHW Pump	HW Pump	Return Fan	Supply Fan	Tower Fan
Albany	687	767	570	669	747	231
Binghamton	701	757	571	591	621	185
Buffalo	696	760	573	623	642	216
Massena	705	754	579	673	718	195
NYC	668	802	550	850	1,038	308
Poughkeepsie	683	775	558	789	959	261
Syracuse	680	771	572	685	738	251

For the city, measure, and building type combinations not addressed above, use data supplied by National Grid shown below. The unit savings estimates are based on data developed by NSTAR for the Massachusetts TRM[1]. These values were trued up to National Grid evaluation studies by computing the ratio of the savings by VFD application from the National Grid Massachusetts Energy Initiative program evaluation to the average value by application across the NSTAR data. This adjustment factor was then applied to each of the NSTAR values. The adjusted savings are shown below.

[1] NSTAR VFD savings taken from Chan, T. *Formulation of a Prescriptive Incentive for the VFD and Motors and VFD Impact Tables at NSTAR*, June, 2010

Measure Unit Savings (kWh/hp)

Building Type	Exh fan	CT fan	CHW pump	Boiler FW pump	HW pump	MAF	Return fan	Supply fan	WLHP circ pump
Elm/HSchool	1,968			1,492		2,088			1,334
Grocery	1,726	392	398	1,275	752	1,368	924	1,007	1,711
Health*	1,863			1,812		1,842			1,912
Hotel/Motel	1,740			1,694		2,067			1,788
Multi-Family**	1,768			1,806		1,892	902	1,025	1,934
Offices	1,840			1,440		2,054			1,685
Restaurant	1,899	424	381	1,526	916	1,613	936	1,059	1,845
Retail	1,707			1,504		1,469			1,561
University/College	2,011			1,788		1,976			1,594
Warehouse	1,828	195	199	1,545	934	1,982	823	936	1,468

*Health includes hospital building types
**Multi-family includes dormitory building types

Peak demand savings were taken from the NSTAR data, as shown below:

Measure Unit Demand Savings (kW/hp)

Building Type	Exh fan	CT fan	CHW pump	Boiler FW pump	HW pump	MAF	Return fan	Supply fan	WLHP circ pump
Elm/HSchool	0.411	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.300
Grocery	0.284	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.194
Health*	0.119	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.061
Hotel/Motel	0.119	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.061
Multi-Family**	0.119	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.061
Offices	0.119	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.061
Restaurant	0.284	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.194
Retail	0.119	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.061
University/College	0.119	-0.025	0.061	0.498	0.498	0.119	0.111	0.070	0.061
Warehouse	0.119	-0.025	0.061	0.498	0.498	0.284	0.111	0.070	0.061

*Health includes hospital building types
**Multi-family includes dormitory building types

Record of Revision

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0	10/15/2010
6-19-13	6/28/2019

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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[1]
	Clothes Dryer	Residential	14	ENERGY STAR® M&I Scoping Report[2]
	Clothes Washer	Residential	11	DEER 2014 EUL ID: Appl-EffCW
	Dehumidifier	Residential	12	ENERGY STAR® Calc[3]
	Dishwasher	Residential	11	DEER 2014 EUL ID: Appl-EffDW
	Refrigerator and Freezer	Residential	14	DEER 2014 EUL ID: Appl-ESRefg
	Soundbar	Residential	7	RPP Product Analysis[4]
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
Building Shell	Air Conditioner – Room (RAC) Cover and Gap Sealer	Residential	5	See note below[5]
	Air Leakage Sealing	Residential	15	GDS[6]

[1] 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
[2] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[3] ENERGY STAR® Dehumidifier Calculator
https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
[4] Retail Products Platform Product Analysis, Last Updated May 25, 2016.
Available from: https://drive.google.com/file/d/0B9Fd3ckbKJp5OEpWSHg1eksyZ1U/view
[5] At least one manufacturer's warranty period. www.gss-ee.com/products.html
[6] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Building Shell	Insulation – Hot Water and Steam Pipe	Residential	15	GDS[7]
	Insulation – Opaque Shell	Residential	25	GDS[8]
	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[9]
	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[10]
	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[11]
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[12]
	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

[7] Ibid.
[8] Ibid.
[9] 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
[10] 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
[11] 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.
[12] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	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[13]
	Boiler and Furnace - Combination ("Combi") Furnace	Residential	20	DEER[14]
	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[15,16]
	Heat Pump - Air Source (ASHP)	Residential	15	DEER 2014 EUL ID: HV-Res HP
	Heat Pump – Ground Source (GSHP)	Residential	25	ASHRAE[17]
	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

[13] 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
[14] Based on DEER value for high efficiency boiler and instantaneous water heater
[15] 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
[16] 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
[17] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
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[18]
	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[19]

[18] NYSERDA Residential Electric Submetering Manual
[19] U.S. DOE, "Thermostatic Radiator Valve Evaluation", January 2015, Table 4. Cost-Benefit Financial Assumptions, pg. 16

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Lighting	Compact Fluorescent Lamp (CFL)	Residential	Coupon – 5	GDS
			Direct Inst. – 7	GDS
			Markdown - 7	GDS
		Multifamily Common Area	9,000 hrs/ annual lighting operating hrs	See note below[20]
	LED Lamp (Directional)	Residential/ Multifamily Common Area	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Lamps[21]
			35,000 or 50,000 hours	DLC[22]
	LED Lamp (Decorative & Omnidirectional)	Residential/ Multifamily Common Area	15,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Lamps

[20] Multi-family common areas tend to have longer run hours than dwelling units. Default value from C&I lighting table is 7,665 hours per year

[21] ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs) V2.0, August 2016, p. 19 (Capped at 20 years). https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2_0%20Revised%20AUG-2016.pdf

[22] Placed on the Qualified Products List by the Design Light Consortium (DLC) 35,000 or 50,000 hours, according to the appropriate Application Category as specified in the DLC's Product Qualification Criteria, Technical Requirement Table version 4.0 or higher

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
Lighting	Light Fixture	LED (Interior)	Residential/ Multifamily	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Fixtures[23]
		LED (Exterior)	Residential/ Multifamily Common Area	35,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Fixtures
		Linear Fluorescent	Residential/ Multifamily Common Area	70,000 hrs / annual lighting operating hrs, or 15 yrs (whichever is less)	DEER 2014[24] EUL ID: ILtg-Lfluor-CommArea
		CFL	Residential/ Multifamily Common Area	22,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	See note below[25]
Lighting Control	Bi-Level Lighting		Multifamily Common Area	15	ComEd[26]
Motors and Drives	Pool Pump		Residential	10	DEER 2014 EUL ID: OutD-PoolPump
Other	Pool Heater		Residential	8	DOE[27]

[23] ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.0, May 2015, p. 17 (Capped at 20 years).
https://www.energystar.gov/sites/default/files/Luminaires%20V2%200%20Final.pdf
[24] Basis value 70,000 hours, capped at 20 years, is common given redecoration patterns
[25] Basis value 22,000 hour ballast life per US EPA. Capped at 20 years as above (2.5 hours per day average lamp operation)
[26] 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
[27] 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[28]
Appliance	Clothes Dryer	C&I	14	ENERGY STAR®M&I Report[29]
	Cooking Equipment	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[30]
	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[31]
	Insulation - Opaque Shell	C&I	30	ET & CEC[32]
	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[33]
	Engineered Air Nozzle	C&I	15	Wisconsin PSC[34]

[28] Based on EUL's for similar control technology
[29] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[30] 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
[31] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures
[32] Energy Trust uses 30 years for commercial applications. CEC uses 30 years for insulation in Title 24 analysis.
[33] 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.
[34] 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[35]
	Refrigerated Air Dryer	C&I	13	Other State TRMs [36]
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[37]
	Boiler and Furnace - Combination (“Combi”) Furnace	C&I	20	DEER[38]
	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

[35] 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

[36] 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.

[37] 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

[38] 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[39]
	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
	Economizer –Dual Enthalpy Air Side	C&I	10	DEER 2014 EUL ID: HVAC-addEcono
	Furnace, Gas Fired	C&I	23	DOE[40],[41]
	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[42]
	Infrared Heater	C&I	17	GDS[43]
	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[44]
	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
HVAC - Control	Direct Digital Control (DDC) System	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Demand Controlled Ventilation (DCV)	C&I	15	DEER 2014 EUL ID: HVAC-VSD-DCV
	Energy Management System	C&I	15	DEER 2014 EUL ID: HVAC-EMS

[39] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003)
[40] 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
[41] 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
[42] ASHRAE Owning and Operating Cost Database
Available from: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1
[43] 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
[44] Wisconsin Public Service Commission: Equipment Useful Life Database, 2013
Excerpt available from: https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
HVAC – Control	Energy Management System – Guest Room	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Outdoor Temperature Setback Control for Hydronic Boiler	C&I	EUL = RUL of Existing Boiler = Boiler EUL – (Current Year – Year of Mfr.)	N/A
	Steam Trap – Low-Pressure Space Heating	C&I	6	DEER 2014 EUL ID: HVAC-StmTrp
	Thermostat – Programmable Thermostat – Wi-Fi (Communicating)	C&I	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve	C&I	15	DOE[45]
Lighting	CFL Lamp	C&I	9,000 hours /annual lighting operating hours	See note below[46]
	CFL Light Fixture	C&I	12	DEER 2014 EUL ID: ILtg-CFLfix-Com
	HID	C&I	70,000 hours /annual lighting operating hours or 15 years (whichever is less)	DEER 2014 EUL ID: ILtg-HPS
	Linear Fluorescent	C&I	70,000 hours /annual lighting operating hours or 15 years, (whichever is less)	DEER 2014[47] EUL ID: ILtg-Lfluor-Elec

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

[46] Based on reported annual lighting operating hours; default value by space type in the technical manual (pp. 109-110)

[47] Basis Value 70,000 hours, capped at 15 years to reflect C&I redecoration and business type change patterns

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting	LED Fixture (other than refrigerated case)	C&I	50,000 hours /annual lighting operating hours or 20 years (whichever is less)	DLC[48]
			35,000 hours /annual lighting operating hours or 20 years (whichever is less)	ENERGY STAR®[49]
			25,000 hours /annual lighting operating hours or 20 years (whichever is less)	Uncertified
	LED Screw-In Lamp	C&I	15,000 hours (decorative) or 25,000 hours (all other)/ annual lighting operating hours or 20 years (whichever is less)	ENERGY STAR®
	Refrigerated Case LED	C&I	16	DEER 2014 EUL ID: GrocDisp-FixtLtg-LED
Lighting - Control	Bi-Level Lighting	C&I	15	ComEd[50]
	Integrated Interior Lighting Control	C&I	15	ComEd[51]
	Non-Integrated Interior Lighting Control	C&I	10	GDS[52]
	Plug-Load Occupancy Sensor	C&I	8	DEER[53]

[48] 50,000 hours per L_{70} requirements prescribed by the DLC's Product Qualification Criteria, Technical Requirement Table version 4.2

[49] 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 2.0. Divided by estimated annual use, but capped at 20 years regardless (consistent with C&I redecoration and business type change patterns

[50] 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

[51] 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

[52] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Available from: https://library.cee1.org/system/files/library/8842/CEE_Eval_MeasureLifeStudyLights%2526HVACGDS_1Jun2007.pdf

[53] DEER value for lighting occupancy sensors

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
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
Other	Pool Heater	C&I	8	DOE[54]
Process Equipment	Steam Trap – Other Applications	C&I	6	DEER 2014 EUL ID: HVAC-StmTrp
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

[54] 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

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
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	6/28/2019

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GLOSSARY

ABBREVIATIONS, ACRONYMS, AND EQUATION VARIABLES	
$\overline{COP}$	Average coefficient of performance
$\overline{\Delta T}$	Average temperature difference
$\overline{EER}$	Seasonal average energy efficiency ratio over the cooling season BTU/watt-hour, (used for a particular climate/building)
ΔkW	Peak coincident demand electric savings
ΔkWh	Annual electric energy savings
ΔQ	Heat difference/loss
ΔT	Temperature difference
Δtherms	Annual gas energy savings
Δ	Change, difference, or savings
A	Amperage
AC	Air conditioning
ACCA	Air Conditioning Contractors of America
ACEEE	American Council for an Energy-Efficient Economy
ACL	Actual cooling load (BTU/h) based on Manual J calculation
ACH	Air change per hour
AFUE	Annual fuel utilization efficiency, seasonal energy efficiency for fuel heating equipment
AHAM	Association of Home Appliance Manufacturers
AHL	Actual heating load (BTU/h) based on Manual J calculation
AHRI	Air Conditioning Heating and Refrigeration Institute
AHU	Air handling unit
AIA	American Institute of Architects
AIR_{loss}	Air loss percentage in a compressed air line
ANSI	American National Standards Institute
APU	Auxiliary power unit
area	Extent of space or surface
ARI	Air-Conditioning & Refrigeration Institute
ARRA	American Recovery and Reinvestment Act of 2009
ASHP	Air source heat pump
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
baseline	Baseline condition or measure
BLDC	Brushless DC electric motor
BG&E	Baltimore Gas and Electric
BTU	British Thermal Unit
BTU/h	British Thermal Units per hour
CAC	Central air conditioner
CADR	Clean Air Delivery Rate (CFM)
Capacity	Cooling output rating, in BTU/h

CAV	Constant air volume
CBECS	Commercial Buildings Energy Consumption Survey
CDD	Cooling degree days - The number of degrees that a day's average temperature is above some baseline temperature, which represents the temperature above which buildings need to be cooled. The baseline temperature is typically 65°F, but may vary based on application.
CEC	State of California Energy Commission
CEE	Consortium for Energy Efficiency
CEF	Combined energy factor (lb/kWh)
CEER	Combined Energy Efficiency Ratio
CF	Coincidence factor
CFL	Compact fluorescent lamp
CFM	Cubic foot per minute
CHW	Chilled water
CHWP	Chilled water pump
CLH	Cooling load hours
CM	Case motor
CMU	Concrete masonry
$Comp_{eff}$	Efficiency of the cooler/freezer compressor (kW/Ton)
COP	Coefficient of performance, ratio of output energy/input energy
CV	Constant volume
CW	Condenser water
CWP	Condenser water pump
Cycle	Compressor duty cycle
$Cycles_{annual}$	Number of dryer cycles per year
D	Demand
DC	Direct current
DCV	Demand controlled ventilation
DEER	Database for Energy Efficiency Resources, California
DF	Demand diversity factor
DFP	Default functional period
DHW	Domestic hot water
Dia	Diameter
DLC	DesignLights Consortium®
DOAS	Dedicated outdoor air system
DOE 2.2	US DOE building energy simulation, and cost calculation tool
DPS	Department of Public Service, New York State
DSF	Demand savings factor
DWHR	Drain Water Heat Recovery
DX	Direct expansion
ECCC NYC	Energy Conservation Construction Code of New York City
ECCC NYS	Energy Conservation Construction Code of New York State
EC	Electronically commutated
Econ	Economizer

Ecotope	Ecotope Consulting, Redlands, CA
ee	Energy efficient condition or measure
EEPS	Energy Efficiency Portfolio Standard
EER	Energy efficiency ratio under peak conditions
EF	Energy factor
Eff	Efficiency
E_c	Combustion efficiency
Efficiency Vermont	State of Vermont Energy and Efficiency Initiatives
E_t	Thermal efficiency
EFLH	Equivalent full-load hours
EIA	Energy Information Administration, US
EISA	Energy Independence and Security Act (EISA) of 2007
ElecSF	Electric Savings Factor
ENERGY STAR®	U.S. Environmental Protection Agency voluntary program
Energy Trust	Energy Trust of Oregon, Inc.
EPA	Environmental Protection Agency (EPA), US
EPACT	Energy Policy and Conservation Act of 2005
EPDM	Ethylene propylene diene monomer roofing membrane
ERV	Energy recovery ventilation
ESF	Energy savings factor
EUL	Effective useful life
EFan	Evaporator fan
Exh	Exhaust
F	Factor
F_{derate}	Aggregate derating factor
F_{elec}	Percentage of energy consumed that is derived from electricity
F_{gas}	Percentage of energy consumed that is derived from gas
F_h	Zone correction for blower door infiltration rate to natural air changes
F_n	Height correction for blower door infiltration rate to natural air changes
F_{peak}	Peak operation factor
FEMP	Federal Energy Management Program
FL	Full-load chiller efficiency under peak conditions
FLH	Full-load hours
Flow	Nozzle flow
FPFC	Four pipe fan coil
ft	Foot
ft^2	Square feet
ft^3	Cubic feet
GasSF	Gas Savings Factor
GDS	GDS Associates, Marietta, GA
Glazing area	Aperture area of glazing
GPD	Gallons Per Day

GPM	Gallons Per Minute
GSHP	Ground source heat pump
ΔH_{vap}	Heat of vaporization (latent heat), in BTU/lb
$H_2O_{savings}$	Water savings
HDD	Heating degree days - The number of degrees that a day's average temperature is below some baseline temperature, which represents the temperature below which buildings need to be heated. The baseline temperature is typically 65°F, but may vary based on application.
HID	High intensity discharge lamp
hp	Horsepower
hp_{max}	Maximum motor horsepower
hp_{peak}	Horsepower at which motor achieves peak efficiency
HP	High performance
hrs	Hours
$hrs_{operating}$	Operating hours
HSPF	Heating seasonal performance factor, BTU/watt-hour, total heating output (supply heat) in BTU (including electric heat) during the heating season / total electric energy heat pump consumed (in watt-hour)
ht	Height
HVAC	Heating, ventilation, and air conditioning
$HVAC_c$	HVAC interaction factor for annual electric energy consumption
$HVAC_d$	HVAC interaction factor at utility summer peak hour
$HVAC_g$	HVAC interaction factor for annual natural gas consumption
HW	Hot water
IECC	International Energy Conservation Code
IEER	Integrated energy efficiency ratio
IESNA	Illuminating engineering Society of North America
IHR	Ice Harvest Rate (lbs/day)
IPLV	Integrated Part-Load Value, a performance characteristic, typically of a chiller capable of capacity modulation.
k	Thermal conductivity
$kBTU/h_{in}$	Input rating (kBTU/h)
$kBTU/h_{out}$	Output rating (kBTU/h)
kgal	Thousand gallons
kSF	Thousand square feet
kW	kilowatts
l	Length
LBNL	Lawrence Berkeley National Laboratory
leakage	Estimate of percent of units not installed in service territory
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LF	Load Factor
Load	Average total weight (lbs) of clothes per drying cycle
LPD	Lighting power density

LRAC	Long-run avoided cost
LSAF	Load shape adjustment factor
MEC	Metropolitan Energy Center
min	Minutes
NACH	Natural Air Changes
NAECA	National Appliance Energy Conservation Act of 1987
NBI	New Buildings Institute
NCEI	National Centers for Environmental Information
NEA	National Energy Alliances
NEAT	National Energy Audit Tool
NEMA	National Electrical Manufacturers Association
NREL	National Renewable Energy Laboratory
NRM	National Resource Management
NSTAR	Operating company of Northeast utilities
NWPPC	Northwest Power Planning Council
NWRTF	Northwest Regional Technical Forum
NY DPS	New York State Department of Public Service
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
^{o}F	Degrees Fahrenheit
OSA	Outdoor supply air
Pa	Pascals, the standard unit of pressure or stress in the International system of units (SI)
PA Consulting	PA Consulting Group
PF	Power factor
Phase	Number of phases in a motor (1 or 3) Single Phase is a type of motor with low horsepower that operates on 120 or 240 volts, often used in residential appliances. Three phase is a motor with a continuous series of three overlapping AC cycles offset by 120 degrees. Three-phase is typically used in commercial applications.
PLR	Power loss reduction
PNNL	Pacific Northwest National Laboratory
PSC	Public Service Commission, New York State
PSF	Proper sizing factor
psia	Atmospheric pressure (lbs per square inch)
psig	Gauge pressure (lbs per square inch)
PSZ	Packaged single zone
PTAC	Package terminal air conditioner
PTHP	Packaged terminal heat pump
Q	Heat
$Q_{reduced}$	Reduced heat
Q_{reject}	Total heat rejection
r	Radius
RA	Return air

RAC	Room air conditioner
RE	Recovery efficiency
RECS	Residential Energy Consumption Survey
RESNET	Residential Energy Services Network
RH	Reduced heat
RLF	Rated load factor
RPM	Revolutions per minute
R-value	A measure of thermal resistance particular to each material
S	Savings
SAPA	State Administrative Procedure Act
SBC	System Benefit Charge
SCFM	Standard cubic feet per minute @ 68 ºF and 14.7 psi standard condition
SEER	Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
SF	Square foot
SHGC	Solar heat gain coefficient
SL	Standby heat loss
Staff	NYS Department of Public Service Staff
standby	Standby Power (watts)
T	Temperature
TAF	Temperature adjustment factor
TDA	Total Display Area (ft^2)
TDEC	Total Daily Energy Consumption
TEFC	Totally enclosed fan cooled
th	Thickness
therm	Unit of heat
THR	Total heat rejection
$Throttle_{fac}$	Throttle factor
TMY	Typical meteorological year
tons	Tons of air conditioning
tons/unit	Tons of air conditioning per unit, based on nameplate data
TRC	Total Resources Cost
TRM	Technical Resource Manual
UA	Overall heat loss coefficient (BTU/h-°F)
UA/L	Overall heat loss coefficient per unit length (BTU/h-°F-ft)
UEF	Uniform Energy Factor
unit	Measure
units	Number of measures installed under the program
UPC	Uniform Plumbing Code under the International Association of Plumbing and Mechanical Officials
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
U-value	Measure of heat loss in a building element/overall heat transfer co-efficient
V	Volt

v	Volume
VAV	Variable air volume
VSD	Variable speed drive
W	watts
W_{ctrl}	Total wattage of controlled lighting (watts)
Wisconsin PSC	State of Wisconsin Public Service Commission

EQUATION CONVERSION FACTORS	
0.000584	Conversion factor used in DOE test procedure
0.00132	Electric efficient storage type water heater replacing standard storage tank water heater. NAECA referenced as function of storage volume.
0.0019	Natural gas efficient storage type water heater replacing standard storage tank water heater. NAECA referenced as function of storage volume.
0.284	Conversion factor, one kW equals 0.284 ton
0.293	Conversion factor, one BTU/h equals 0.293071 watt
0.473	Conversion factor (liters/pint)
0.67	Natural gas water heater Energy Factor
0.746	Conversion factor (kW/hp), 746 watts equals one electric horsepower
0.97	Electric resistance water heater Energy Factor
1.08	Specific heat of air × density of inlet air @ 70ºF × 60 min/hr
1.6	Typical refrigeration system kW/ton
3.412	Conversion factor, one watt-hour equals 3.412 BTU
3.517	Conversion factor, one ton equals 3.517 kilowatts
8.33	Energy required (BTU's), to heat one gallon of water by one degree Fahrenheit
12	(kBTU/h)/ton of air conditioning capacity
24	Hours in one day
67.5	Ambient air temperature °F
91	Days in winter months
100	Conversion factor, one therm equals 100 kBTU
274	Days in non-winter months.
365	Days in one year
3,412	Conversion factor, one kWh equals 3,412 BTU
8,760	Hours in one year
1,000	Conversion factor, one kW equals 1,000 watts
12,000	Conversion factor, one ton equals 12,000 BTU/h
100,000	Conversion factor, (BTU/therm), one therm equals 100,000 BTU's

Record of Revision

Record of Revision Number	Issue Date
0	12/10/2014
6-15-4	6/1/2014
1-17-9	12/31/2016
6-17-17	6/30/2017
9-17-12	9/30/2017
12-17-18	12/31/2017
3-18-22	3/29/2018
6-19-15	6/28/2019

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