Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
3-19-8	R	3/29/2019	3/29/2019	C/I Vending Machine and Novelty Cooler Control	Updated Measure Description language to clarify application; Corrected hours calculation language; Updated Compliance Efficiency section to clarify qualifying condition	Pg. 255
3-19-9	R	3/29/2019	3/29/2019	C/I Air Compressor	Included footnote in Measure Description section summarizing the review of a recent evaluation; Added provisions for larger equipment.	Pg. 281
3-19-10	R	3/29/2019	3/29/2019	C/I Interior Lighting Control	Updated Measure Description section language to clarify application; Updated Energy Savings Factor terms, definitions and values; Added Networked Lighting Controls minimum required occupancy hours table	Pg. 432
3-19-12	A	3/29/2019	3/29/2019	C/I Combination ("Combi") Boilers and Furnaces	New Measure Added	Pg. xx
3-19-13	A	3/29/2019	3/29/2019	C/I Pool Heater	New Measure Added	Pg. xx
3-19-14	A	3/29/2019	3/29/2019	C/I Refrigerated Case Doors	New Measure Added	Pg. xx
3-19-15	R	3/29/2019	3/29/2019	Appendix P	Updated EUL entries for all measures contained in this Record of Revision	Pg. 746

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between January 31, 2019 – March 29, 2019.

VENDING MACHINE AND NOVELTY COOLER CONTROL

Measure Description

This measure covers the installation of time clocks or occupancy sensors on refrigerated vending machines and novelty coolers to ensure units maintain desired product temperatures when required. The time clock control mechanism is a programmed-schedule time clock that is assumed to be set to turn the equipment off coincident with the facility closing time and turn equipment on one hour before opening time to allow the products to return to the desired sale temperature.

The occupancy sensor control mechanism uses an infrared sensor to turn off the vending machine when the surrounding area is unoccupied. The device also monitors the ambient temperature and powers up the machine as required to keep products cool. Additionally, the sensor monitors the electrical current used by the machine to ensure it is not turned off during a compressor cycle to prevent a high head pressure start from occurring.

This measure is only applicable to vending machines without a low power mode. A low power mode is a state in which a vending machine's lighting, refrigeration, and/or other energy using systems are automatically adjusted (without user intervention) such that they consume less energy than they consume in an active vending environment.[1] This measure is only applicable to vending machines and novelty coolers containing non-perishable products.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times (kW/unit) \times hrs_{off} \times Cycle$$

Peak Coincident Demand savings

$$\Delta kW = N/A$$

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
(kW/unit)	= Vending machine power (kW), based on nameplate Volts, Amps, Phase and Power Factor
hrs_{off}	= Unit off hours per year
Cycle	= Compressor duty cycle

[1] 10 CFR 431 Subpart Q, Appendix B 1.2 Definitions

Summary of Variables and Data Sources

Variable	Value	Notes
(kW/unit)	$= \frac{Volts \times Amps \times \sqrt{Phase} \times PF}{1{,}000}$	Based on nameplate Volts, Amps, Phase and Power Factor. If power factor is unknown, use a default value of 0.55.[2]
hrs_{off}	Time clock: From application Occupancy Sensor: 2,891	Based on control type. For time clocks, off hours are equivalent to annual facility closed hours multiplied by facility operating days. If unknown, look up in Operating Hours section below based on facility type.
Cycle	0.45	Compressor average duty cycle. [3]

Coincidence Factor (CF)

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

Baseline Efficiencies from which Incentives are Calculated

The baseline condition is a vending machine or novelty cooler containing non-perishable products without time clock or occupancy IR sensing/load sensing control.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is the installation of time clock or occupancy IR sensing/load sensing control installed on a vending machine or novelty cooler containing non-perishable products where controls were not previously installed.

Operating Hours

Novelty coolers and refrigerated vending machines are assumed to be connected 24 hours per day, 365 days per year. In the baseline case, these units operate during all hours and cycle according to the duty cycle cited above.

With time clock control, units are automatically shut off when the facility closes and turned back on one hour prior to the facility opening to allow the system to return the contents to their desired temperature. Energy savings are calculated based on the system off hours due to installed time clock control. If unknown, use the default off hours based on building type from the table below. This table was developed by subtracting the default lighting hours in the C&I Interior Lamps and Fixtures measure in this TRM from 8,760, and subtracting 365 from the result (assumes 365 days of facility operation). Facilities expected to operate 24/7 are excluded.

[2] Analysis of Cooler Control Energy Conservation Measures: Final Report, Select Energy Services, Inc., March 2004
[3] Ibid, Table 5-5

Facility Type	hrs_{off} (hrs/yr)	Facility Type	hrs_{off} (hrs/yr)
Auto Related[a]	5,585	Manufacturing Facility	5,538
Bakery	5,541	Medical Offices	4,647
Banks	4,647	Motion Picture Theatre	6,441
Church	6,440	Museum	4,647
College– Cafeteria[b]	5,682	Nursing Homes	2,555
College – Classes	5,809	Office (General Office Types)[b]	5,382
College - Dormitory	5,329	Parking Garages	4,027
Commercial Condos[c]	5,295	Parking Lots	4,295
Convenience Stores	2,019	Penitentiary	2,918
Convention Center	6,441	Performing Arts Theatre	5,809
Court House	4,647	Post Office	4,647
Dining: Bar Lounge/Leisure	4,213	Pump Stations	6,446
Dining: Cafeteria / Fast Food	1,939	Refrigerated Warehouse	5,793
Dining: Family	4,213	Religious Building	6,440
Entertainment	6,443	Restaurants	4,213
Exercise Center	2,559	Retail	4,932
Fast Food Restaurants	2,019	School / University	6,208
Fire Station (Unmanned)	6,442	Schools (Jr./Sr. High)	6,208
Food Stores	4,340	Schools (Preschool/Elementary)	6,208
Gymnasium	5,809	Schools (Technical/Vocational)	6,208
Industrial - 1 Shift	5,538	Small Services	4,645
Industrial - 2 Shift	3,665	Sports Arena	6,441
Industrial - 3 Shift	1,764	Town Hall	4,647
Laundromats	4,339	Transportation	1,939
Library	4,647	Warehouse (Not Refrigerated)	5,793
Light Manufacturers[b]	5,782	Waste Water Treatment Plant	1,764
Lodging (Hotels/Motels)	5,331	Workshop	4,645
Mall Concourse	3,562		

[a] New car showrooms and Big Box retail stores with evening and/or weekend hours should use the Facility Type "Retail" for vending machine and novelty cooler off hours
[b] Lighting operating hours data from the 2008 California DEER Update study
[c] Lighting operating hours data for offices used

Annual occupancy sensor control hours are assumed to be 2,891 based on 33% energy savings of vending machine or novelty with installed device.[4]

Effective Useful Life (EUL)

See Appendix P.

[4] Analysis of NREL Cold-Drink Vending Machines for Energy Savings, June 2003.

Ancillary Fossil Fuel Savings Impacts

Reduced refrigeration system run hours during facility operation will result in a slight increase in space heating requirements and a slight decrease in space cooling requirements. These effects are not considered in the prescribed savings methodology.

Ancillary Electric Savings Impacts

Reduced refrigeration system run hours during facility operation will result in a slight increase in space heating requirements and a slight decrease in space cooling requirements. These effects are not considered in the prescribed savings methodology.

References

1. 10 CFR 431 Subpart Q, Appendix B, 1.2 Definitions
   Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=bffd54323b0e3f933976ce4b4ad86e55&mc=true&node=pt10.3.431&rgn=div5#ap10.3.431_1296.b
2. VendingSolutions, Vending Machine Knowledge Base
   Available from: https://www.vendingsolutions.com/faq
3. Analysis of Cooler Control Energy Conservation Measures: Final Report, Select Energy Services, Inc., March 2004
   Available from: https://forum.cee1.org/system/files/library/1220/392.pdf
4. Analysis of NREL Cold-Drink Vending Machines for Energy Savings, NREL, June 2003
   Available from: https://www.researchgate.net/profile/Michael_Deru/publication/242168498_Analysis_of_NREL_Cold-Drink_Vending_Machines_for_Energy_Savings/links/54bd240d0cf218da939190ab/Analysis-of-NREL-Cold-Drink-Vending-Machines-for-Energy-Savings.pdf?origin=publication_detail

Record of Revision

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1	10/15/2010
6-18-7	6/26/2018
3-19-8	3/29/2019

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COMPRESSED AIR

AIR COMPRESSOR

Measure Description

This measure covers the installation of oil-flooded, rotary screw air compressors with variable frequency drives or variable displacement controls and properly sized air receivers in commercial and industrial compressed air systems (single compressor systems only). Inlet valve modulation, which modulates the compressor by throttling the air inlet and load/unload control, which switches the compressor to unload when the cut-out pressure set point is reached, are inefficient means of compressed air system control under part load conditions. Variable frequency drives vary capacity by controlling the frequency of the electrical signal to and speed of the motor while variable displacement controls change compressor capacity by varying the amount of the compressor used to compress air. Both represent a significant improvement in part load operating efficiency and savings over the baseline condition.[1]

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times hp_{comp} \times (\Delta kW/hp) \times hrs$$

Peak Coincident Demand Savings

$$\Delta kW = units \times hp_{comp} \times (\Delta kW/hp) \times CF$$

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
hp_{comp}	= Horsepower of air compressor
(ΔkW/hp)	= Demand electric savings per horsepower
hrs	= Annual operating hours of air compressor
CF	= Coincidence factor

[1] The Impact Evaluation of Custom Compressed Air, conducted by DNV GL for Niagara Mohawk Power Corporation d/b/a National Grid (approved March 2017), was reviewed for findings relevant to this measure. The findings of this report, which quantifies kWh and peak summer kW savings and associated realization rates for custom compressed air measures at 25 unique sites, do not directly inform the algorithms, key inputs or default values found in this energy savings estimation methodology. As such, no changes have been applied as a result of this review.

Summary of Variables and Data Sources

Variable	Value	Notes
hp_{comp}		From application
(ΔkW/hp)		Lookup in table below based on compressor size and control strategy.[2]
hrs		From application
CF	0.8	

Air Compressor Savings (ΔkW/hp)

Control type	Compressor hp	ΔkW/hp
Variable Frequency Drive	≥ 15 and < 25	0.207
Variable Frequency Drive	≥ 25 and < 75	0.206
Variable Frequency Drive	≥ 75	0.216
Variable Displacement	≥ 50 and < 75	0.116
Variable Displacement	≥ 75	0.141

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.8.[3]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is an oil-flooded, rotary screw compressor utilized in a single compressor system meeting the requirements of ISO Standard 8573.1 with inlet modulating or load/unload control and blow down capability.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an oil-flooded, rotary screw compressor utilized in a single compressor system meeting the requirements of ISO Standard 8573.1 with variable speed drive or variable displacement capacity control and a properly sized air receiver. Flow controller must be used to maintain 5-10 psi pressure difference between receiver and distribution system.

Operating Hours

The operating hours of compressed air systems vary widely and shall be defined by the application.

[2] For equipment with < 75 hp: *No source specified – update pending availability and review of applicable references.*
For equipment with ≥ 75 hp: Energy savings factors were developed by using U.S. Dept. of Energy part load data for different compressor control types as well as load profiles from 50 facilities employing air compressors. This data suggests an average 17% load reduction compared to baseline for Variable Displacement and an average 26% load reduction compared to baseline for Variable Frequency Drives and an average 90% operating efficiency for new compressor equipment. ΔkW/hp values were derived using these assumptions in the form: % Savings x 0.746\System Efficiency.

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. "Improving Compressed Air System Performance": A sourcebook for Industry, U.S. Dept. of Energy, November 2003.
   Available from:
   https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/compressed_air_sourcebook.pdf
2. Impact Evaluation of Custom Compressed Air, DNV GL, March 2017
   Available from:
   http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BE21FC3D0-70BC-426E-B35B-85E082640361%7D

Record of Revisions

Record of Revision Number	Issue Date
1	10/15/2010
12-17-9	12/31/2017
3-19-9	3/29/2019

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LIGHTING – CONTROL

INTERIOR LIGHTING CONTROL

Measure Description

This measure covers the installation of lighting control systems on lighting in interior spaces where these controls are not mandated by federal, state, municipal or local code. Lighting control systems covered under this measure include occupancy sensors, stepped and dimming daylighting controls and networked lighting control systems. Interior spaces are defined as any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting. These systems save energy and peak demand by shutting off power to lighting fixtures when the space is unoccupied or illumination is not required. They also save energy and demand by reducing power to lighting systems to correct for over-illumination due to excessive lamp output or the presence of daylight.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{W_{ctrl}}{1{,}000}\right) \times hrs_{baseline} \times ESF \times (1 + HVAC_c)$$

Peak Coincident Demand Savings

$$\Delta kW = \left(\frac{W_{ctrl}}{1{,}000}\right) \times ESF \times (1 + HVAC_d) \times CF$$

Annual Gas Energy Savings

$$\Delta therms = \left(\frac{W_{ctrl}}{1{,}000}\right) \times hrs_{baseline} \times ESF \times HVAC_g$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
W_{ctrl}	= Total wattage of controlled lighting (Watts)
1,000	= Conversion factor, one kW equals 1,000 Watts
hrs	= Lighting operating hours
baseline	= Baseline condition or measure
$HVAC_c$	= 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)
ESF	= Energy savings factor
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
W_{ctrl}		Connected load of controlled lighting fixtures (in Watts), from application
$hrs_{baseline}$		Lighting operating hours. From application or see Operating Hours section below.
$HVAC_c$	Unconditioned Space: 0	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	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.
$HVAC_g$	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.
ESF		See Energy Savings Factors table below
CF	1.0	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

Energy Savings Factor[1]

The ***energy savings factor*** (ESF) is the average annual reduction in electric consumption achieved by a particular control measure type. Energy savings factors for various automated lighting control types are specified in the table below.

Control Type	ESF
Occupancy Sensor	0.30
Daylight Dimming Control	0.30
Daylight Stepped Control	0.20
Networked Lighting Control	High Occupancy Hours (See Operating Hours section below): 0.47[2] Otherwise: 0.35

- ***Occupancy Sensor*** – Reduces lighting operating hours by switching off lighting in unoccupied spaces.
- ***Daylight Dimming Control*** – Reduces lighting output to a set level in response to natural daylighting using continuous dimming capability.
- ***Daylight Stepped Control*** – Reduces lighting output to a set level in response to natural daylighting using stepped dimming capability.

[1] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 3: Commercial and Industrial Lighting Controls Evaluation Protocol, National Renewable Energy Laboratory, September 2017, p. 15

[2] Energy Savings from Networked Lighting Control (NLC) Systems, DesignLights Consortium®, September 2017, pg 7

- ***Networked Lighting Control*** – A networked lighting control system consists of an intelligent network of individually addressable luminaires and control devices, allowing for application of multiple control strategies, programmability, building- or enterprise-level control, zoning and rezoning using software, and measuring and monitoring.[3]

Coincidence Factor (CF)

The prescribed coincidence factor for commercial indoor lighting measures is 1.0. [4]

Baseline Efficiencies from which Savings are Calculated

The baseline case for this measure is a lighting system with manual or time-switch controls. This measure is not applicable in spaces for which occupancy or daylight-responsive controls are required by federal, state or local code. Refer to chapter C405.2 Lighting Controls (Mandatory) of the Energy Conservation Construction Code of New York State[5] (ECCCNYS) and the New York City Energy Conservation Code[6] (NYCECC) for details.

Compliance Efficiency from which Incentives are Calculated

The compliance case is a lighting system with occupancy and/or daylight-responsive controls designed and installed in accordance with manufacturers' and/or designer recommendations.

Operating Hours

The baseline lighting operating hours are the average operating hours for all fixtures subject to lighting control measures before the lighting controls are installed. This information shall be taken from the application. If unavailable, refer to the "Operating Hours" section of the Commercial and Industrial Interior and Exterior Lamps and Fixtures measure for default hours of operation.

Networked Lighting Controls in facilities with occupancy hours that meet or exceed the hours outlined in the table below qualify as high occupancy hour facilities and achieve greater savings.[7]

Facility Type	Occupancy Hours
Assembly	≥ 5,000
School	≥ 5,000
Manufacturing	≥ 4,000
Retail	≥ 7,000
Restaurant	≥ 6,000
Office	≥ 4,500
Warehouse	≥ 6,000

[3] Networked Lighting Controls V3.0 Requirements, DesignLights Consortium®
[4] *No source specified – update pending availability and review of applicable references.*
[5] ECCCNYS 2016; C405.2: Lighting Controls (Mandatory)
[6] NYCECC 2016; C405.2: Lighting Controls (Mandatory)
[7] Energy Savings from Networked Lighting Control (NLC) Systems, DesignLights Consortium®, September 2017, Figure 2. Only the building types listed are eligible for high occupancy designation.

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 the 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 the prescribed energy savings calculation methodology.

References

1. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 3: Commercial and Industrial Lighting Controls Evaluation Protocol, National Renewable Energy Laboratory, September 2017
   Available from: https://www.nrel.gov/docs/fy17osti/68559.pdf
2. Networked Lighting Controls V3.0 Requirements, DesignLights Consortium®
   Available from: https://www.designlights.org/workplan/networked-lighting-controls-specification/
3. Energy Savings from Networked Lighting Control (NLC) Systems, DesignLights Consortium®, September 21, 2017
   Available from: https://www.designlights.org/lighting-controls/reports-tools-resources/nlc-energy-savings-report/
4. ECCCNYS 2016, per IECC 2015; Chapter C405.2: Lighting Controls (Mandatory)
   Available from: https://codes.iccsafe.org/public/document/IECC2015NY-1/chapter-4-ce-commercial-energy-efficiency
5. NYCECC 2016: Chapter C405.2: Lighting Controls (Mandatory)
   Available from: https://www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page

Record of Revision

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1	10/15/2010
6-15-4	6/1/2015
1-16-7	12/31/2015
9-17-7	9/30/2017
3-19-10	3/29/2019

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

COMBINATION ("COMBI") BOILERS AND FURNACES

Measure Description

This measure covers the installation of gas combination (or "combi") boilers and furnaces, which are defined as high-efficiency, instantaneous water heaters with a heating designation. Combi-boilers are all-in-one high-efficiency space heating systems with integrated capability for providing instantaneous domestic hot water, while combi-furnaces supply both domestic tankless hot water and forced air heating. These units realize energy savings through increased thermal efficiency and by taking cold water straight from the main supply and heating it as needed, which eliminates the need for a separate hot water storage tank and avoids standby losses. Qualifying equipment must be in accordance with ASHRAE Standard 124-2007 (RA 2016).[1] This measure only applies to systems with modulating/staging capability and no water storage tank.

This measure only captures the gas savings impacts of combi-boilers and combi-furnaces. While electric combi-boilers exist, more investigation and research is required before an approach for estimating associated energy savings can be developed.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = \Delta therms_{SH} + \Delta therms_{DHW}$$

$$\Delta therms_{SH} = units \times \frac{kBTU/h_{in}}{unit} \times \left(\frac{Eff_{ee}}{Eff_{baseline}} - 1\right) \times \frac{EFLH_{heating}}{100}$$

$$\Delta therms_{DHW} = units \times \left[\frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left(\frac{1}{E_{t,baseline}} - \frac{1}{Eff_{ee}}\right) + \frac{UA_{baseline}}{E_{t,baseline}} \times \frac{\Delta T_{amb}}{100{,}000} \times 8{,}760\right]$$

[1] ASHRAE Standard 124-2007 (RA 2016) – Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances (ANSI Approved)

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
$\Delta therms$	= Annual gas energy savings
$\Delta therms_{DHW}$	= Annual domestic hot water savings associated with installation of a high-efficiency combi-boiler or combi-furnace
$\Delta therms_{SH}$	= Annual space heating savings associated with installation of a high-efficiency combi-boiler or combi-furnace
units	= Number of measures installed under the program
$kBTU/h_{in}$	= Space heating fuel input rating
$_{baseline}$	= Baseline condition or measure
$_{ee}$	= Energy efficient condition or measure
Eff	= Energy efficiency (0-100%)
$EFLH_{heating}$	= Heating equivalent full-load hours
GPD	= Gallons per day
ΔT_{main}	= Average difference between the cold inlet temperature and the hot water delivery temperature (°F)
E_t	= Water heating designation thermal efficiency
UA	= Overall heat loss coefficient (BTU/h-°F)
ΔT_{amb}	= Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
100	= Conversion factor, (kBTU/therm), one therm equals 100 kBTU's
365	= Days in one year
8.33	= Energy required (BTU's), to heat one gallon of water by one degree Fahrenheit
100,000	= Conversion factor, (BTU/therm), one therm equals 100,000 BTU's
8,760	= Hours in one year

Summary of Variables & Data Sources

Variable	Value	Notes/References
$kBTUh_{in}$		Nominal heating input capacity is the nameplate input rating of the unit in kBTU/hr, from application.
$Eff_{baseline}$		See Baseline Efficiencies section below.
Eff_{ee}		From application.
$EFLH_{heating}$		Lookup based on building type and location in Appendix G.
GPD		From application, or lookup/calculate based on building type, square footage and occupancy from GPD table below.
ΔT_{main}	$T_{set} - T_{main}$	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F).
ΔT_{amb}	70 $T_{set} - T_{amb}$	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F).

Variable	Value	Notes/References
T_{set}	140	Water heater set point temperature (°F).[2]
T_{main}		Supply water temperature in water main (°F). Lookup in Cold Water Inlet Temperature table below based on nearest city.
T_{amb}	70	Surrounding ambient air temperature (°F).[3]
$E_{t,baseline}$	0.80	Water heating designation thermal efficiency of the baseline condition.[4]
$UA_{baseline}$	7.85	Overall heat loss coefficient of the baseline condition (BTU/h-°F).[5]

Gallons per Day (GPD)

The average daily hot water usage, expressed in gallons per day, for several commercial facility types is tabulated below. Daily hot water usage can be calculated based on the GPD and site-specific metric in the Rate column, or default values can be referenced directly from the GPD column.

Building Type	GPD	Rate	Notes/Assumptions	Source
Assembly	239	7.02 GPD per 1,000 SF	Assumes 10% hot water, 34,000 SF	EIA[6]: Public Assembly
Auto Repair	25	4.89 GPD per 1,000 SF	Assumes 10% hot water, 5,150 SF	EIA: Other
Big Box Retail	448	3.43 GPD per 1,000 SF	Assumes 10% hot water, 130,500 SF	EIA: Mercantile
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL[7]: School with Showers
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation[8]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School
Fast Food Restaurant	500	500 GPD per restaurant		FSTC[9]: Quick Service
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service
Grocery	172	3.43 GPD per 1,000 SF	Assumes 10% hot water, 50,000 SF	EIA: Mercantile
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers
Hospital	16,938	54.42 GPD per 1,000 SF	Assumes 40% hot water, 250,000 SF	EIA: Health Care, Inpatient
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 40% hot water, 200,000 SF	EIA: Lodging
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office

[2] Per OSHA recommendations for prevention of Legionella bacterial growth (https://www.osha.gov/SLTC/etools/hospital/hazards/leg/leg.html)

[3] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.

[4] 10 CFR 431.110 (a)

[5] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was calculated for a minimally code compliant gas storage water heater found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 Btu/h assumed). Results of heat loss coefficient evaluation for this assumed baseline is used to represent the $UA_{baseline}$ term.

[6] U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings, Table WD1. Daily water consumption in large commercial buildings, 2012

[7] National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011

[8] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016

[9] Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010

Building Type	GPD	Rate	Notes/Assumptions	Source
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 10% hot water, 130,000 SF	EIA: Mercantile
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 10% hot water, 100,000 SF	EIA: Other
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 40% hot water, 30,000 SF	EIA: Lodging
Multifamily High-Rise	4,600	46 GPD per unit	Assumes 100 units	Water Research Foundation
Multifamily Low-Rise	552	46 GPD per unit	Assumes 12 units	Water Research Foundation
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 10% hot water, 92,000 SF	EIA: Warehouse and Storage
Religious	77	7.02 GPD per 1,000 SF	Assumes 10% hot water, 11,000 SF	EIA: Public Assembly
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 10% hot water, 8,000 SF	EIA: Mercantile
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 10% hot water, 500,000 SF	EIA: Warehouse and Storage
Other	Calculate	4.89 GPD per 1,000 SF	Assumes 10% hot water	EIA: Other

Cold Water Inlet Temperature (T_{main})

Supply water main temperatures vary according to climate and are approximately equal to the annual average outdoor temperature plus 6°F.[10] Supply main temperatures based on the annual outdoor temperature are shown below.

City	Annual average outdoor temperature[11] (°F)	T_{main} (°F)
Albany	48.3	54.3
Binghamton	46.3	52.3
Buffalo	48.3	54.3
Massena	43.5	49.5
NYC	55.4	61.4
Poughkeepsie	49.8	55.8
Syracuse	48.3	54.3

Coincidence Factor (CF)

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

Baseline Efficiencies from which Savings are Calculated

Space Heating Component

The baseline condition for the space heating component of combi-boilers and combi-furnaces shall be consistent with code requirements for commercial gas furnaces and boilers defined by the Code of Federal Regulations (CFR) and subsequently adopted by the Energy Conservation Construction Code of New York State[12] and the New York City Energy Conservation Code[13]. The table below establishes the prescribed baseline efficiency values for combi-furnaces and combi-boilers by input capacity. For combi-furnaces < 225 kBTU/h, selection of efficiency rating (AFUE or E_t) should align with the rating specification of the qualifying equipment.

[10] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory

[11] Average annual outdoor temperatures taken from NCDC 1981-2010 climate normals

[12] ECCCNYS 2016, Table C403.2.3(4) and Table C403.2.3(5)

[13] NYCECC 2016; Table C403.2.3(4) and Table C403.2.3(5)

Equipment Type	Size Range	ECCCNYS Minimum Efficiency for Climate Zones 4, 5 and 6	NYCECC Minimum Efficiency for NYC Boroughs in Climate Zone 4
Combi-furnace	< 225 kBTU/h	0.78 AFUE or 0.80 E_t	0.78 AFUE or 0.80 E_t
	≥ 225 kBTU/h	0.80 E_t	0.80 E_t
Combi-boiler	< 300 kBTU/h	0.80 AFUE	0.80 AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	0.80 E_t	0.80 E_t
	> 2,500 kBTU/h	0.82 E_c	0.82 E_c

Domestic Hot Water Component

The baseline condition is a standard efficiency storage type water heater with a thermal efficiency of 80%[14] and heat loss coefficient of 7.85 BTU/hr-°F.[15]

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a combi-boiler unit with a heating designation efficiency of 90% AFUE, E_t or E_c or greater or a combi-furnace unit with a heating designation efficiency of 92% AFUE or E_t or greater. Qualifying systems must be equipped with modulating/staging capability and no water storage tank. Units shall be in accordance with ASHRAE Standard 124-2007 (RA 2016).[16]

Operating Hours

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

Domestic hot water heaters are assumed to be available for operation 8,760 hours per year, and it is assumed standby losses in the baseline case are incurred 8,760 hours per year.

[14] 10 CFR 431.110 (a)

[15] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was calculated for a minimally code compliant gas storage water heater found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 Btu/h assumed). Results of heat loss coefficient evaluation for this assumed baseline is used to represent the $UA_{baseline}$ term.

[16] ASHRAE Standard 124-2007 (RA 2016) – Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances (ANSI Approved)

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

High efficiency furnaces may be packaged with high efficiency cooling equipment and/or electronically commutated blower motors, which may provide electricity savings. Draft fans, when present, will increase electricity consumption.

References

1. ASHRAE Standard 124-2007 (RA 2016) – Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances (ANSI Approved)
2. OSHA Legionnaire's Disease eTool: Section II: C-1. Domestic Hot-Water Systems
   Available from: https://www.osha.gov/SLTC/etools/hospital/hazards/leg/leg.html
3. 10 CFR 431.110 Energy conservation standards and their effective dates
   Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=64f994924a5f31b841cab23a6d543f85&mc=true&node=pt10.3.431&rgn=div5#se10.3.431_1110
4. 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters
   Available from: https://energy.gov/sites/prod/files/2016/08/f33/Water%20Heaters%20Test%20Procedure%20SNOPR.pdf
5. AHRI Directory of Certified Product Performance
   Available from: https://www.ahridirectory.org/ahridirectory/pages/home.aspx
6. U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings, Table WD1. Daily water consumption in large commercial buildings, 2012
   Available from: https://www.eia.gov/consumption/commercial/reports/2012/water/
7. National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011
   Available from: https://www.nrel.gov/docs/fy11osti/50118.pdf
8. Water Research Foundation: "Residential End Uses of Water, Version 2: Executive Report", April 2016
   Available from: http://www.waterrf.org/PublicReportLibrary/4309A.pdf
9. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010
   Available from: https://fishnick.com/design/waterheating/Water_Heating_Design_Guide_Final_FNi_disclaimer.pdf

10. Burch, Jay and Craig Christensen; "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory.
Available from: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.515.6885
11. NOAA National Centers for Environmental Information – NCEI 1981-2010 Climate Normals
Available from: https://www.ncdc.noaa.gov/cdo-web/datatools/normals
12. ECCCNYS 2016, per IECC 2015; Table C403.2.3(4): Warm-Air Furnaces And Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces And Unit Heaters, Minimum Efficiency Requirements & Table C403.2.3(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers.
Available from: https://codes.iccsafe.org/public/document/IECC2015/chapter-4-ce-commercial-energy-efficiency
13. NYCECC 2016; Table C403.2.3(4): Warm-Air Furnaces And Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces And Unit Heaters, Minimum Efficiency Requirements & Table C403.2.3(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers
Available from:
https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHC4.pdf&section=energy_code_2016

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OTHER

POOL HEATER

Measure Description

This measure covers the installation of high efficiency natural gas pool heaters.[1] Gas-fired pool heaters are designed for heating non-potable water and employ natural gas burners. High-efficiency natural gas heaters can have thermal efficiency ratings as high as 95%.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = units \times (therms/(kBTU/h)_{baseline} - therms/(kBTU/h)_{ee}) \times kBTU/h$$

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
therms/(kBTU/h)	= Annual gas consumption per pool heater heating capacity
kBTU/h	= Pool heater input heating capacity, in kBTU/h

Summary of Variables and Data Sources

Variable	Value	Notes
$therms/(kBTU/h)_{baseline}$	1.46	From the annual energy consumption table below, based on a thermal efficiency rating of 82%.
$therms/(kBTU/h)_{ee}$		Look up from energy consumption table below based on thermal efficiency rating of fuel efficient pool heater. Interpolation may be performed for pool heater efficiencies not listed.

[1] Similar to other measures in the NY TRM, this measure will continue to be reviewed for accuracy and for potential updates, based on up-take in programs, changes in codes and standards, and the availability of other measure-specific information.

Variable	Value	Notes
kBTU/h		Pool heater input capacity as indicated on equipment nameplate or manufacturer specifications, from application.

Annual Energy Consumption[2]

Thermal Efficiency (%)	Annual Gas Consumption ($therms_{ee}$)
82 (baseline)	1.46
84	1.38
86	1.34
90	1.28
95	1.22

Coincidence Factor (CF)

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

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a gas-fired pool heater with a thermal efficiency of 82% as mandated by federal standards. [3]

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a gas-fired pool heater that has a thermal efficiency of 84% or greater. [4]

Operating Hours

Pool heater run hours are embedded in the values found in the Annual Energy Consumption table provided above. The derivation assumes a 250-kBTU/h input pool heater, 26.5% of heaters equipped with a pilot light with an input rate of 1-kBTU/h, an average pilot light operating hours of 4,464 hours per year, and a distribution range of pool operational hours from 235 to 8,760 per year.

Effective Useful Life (EUL)

See Appendix P.

[2] US DOE, Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters, Chapter 7, Table 7.4.2: Annual Energy Consumption for Gas-Fired Pool Heaters. The derivation assumes a 250-kBTU/h pool heater and 26.5% of heaters equipped with a pilot light with an input rate of 1-kBTU/h.
[3] 10 CFR 430.32.(k)(1)
[4] Compliance requirement based on SoCal Gas minimum thermal efficiency to qualify for incentive (accessed 11/27/2018)

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

Analysis of baseline and high-efficiency gas pool heaters conducted using the DOE test procedure suggests that auxiliary and stand-by electric loads are slightly higher for more efficient equipment.[5] The magnitude of these effects is considered negligible relative to anticipated gas savings and electric impacts have thus been excluded from the prescribed methodology.

References

1. 10 CFR 430.32 Energy and water conservation standards and their compliance dates. Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=e2b12730e1b0fd7608318eb139d57b10&mc=true&n=pt10.3.430&r=PART&ty=HTML#se10.3.430_132
2. Department of Energy; Notice of Proposed Rulemaking Technical Support Document Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters, Chapter 7: Energy Use Characterization, November 23, 2009 Available from: https://www.regulations.gov/contentStreamer?documentId=EERE-2006-STD-0129-0170&attachmentNumber=8&contentType=pdf
3. SoCal Gas, Pool Heater List (accessed November 27, 2018) Available from: https://www.socalgas.com/pool-heater-list

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[5] US DOE, Energy Conservation Standards for Residential Water Heaters, Direct Heating Equipment, and Pool Heaters, Chapter 7, Table 7.4.2: Annual Energy Consumption for Gas-Fired Pool Heaters

REFRIGERATION

REFRIGERATED CASE DOORS

Measure Description

This measure covers the installation of doors on existing open vertical refrigerated cases. Case doors are installed over open refrigerated cases to prevent air infiltration between the refrigerated case and the facility space. This barrier alleviates cooling loads on the refrigeration system and heating loads on the conditioned space.

This measure is applicable to refrigerated case doors with and without anti-condensation heaters. Standard refrigerated case doors include anti-condensation heaters in the frames, doors, or within the glass to prevent condensation from forming and obstructing view of refrigerated products. High efficiency doors with no anti-condensation heaters use a combination of multiple layers of glass, low-conductivity filler gas, and low-emissivity glass coatings to prevent condensation.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = l_{door} \times (\Delta kWh/ft) \times \left(1 - \frac{EFLH_{cooling}}{8{,}760} \times \frac{COP_{ref}}{COP_{HVAC}}\right)$$

Peak Coincident Demand Savings

$$\Delta kW = l_{door} \times \frac{(\Delta kWh/ft)}{8{,}760} \times CF$$

Annual Gas Energy Savings

$$\Delta therms = l_{door} \times \frac{(\Delta kWh/ft) \times 3{,}412}{100{,}000} \times \frac{EFLH_{heating}}{8{,}760} \times \frac{1}{Eff}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
l_{door}	= Length of cooler or freezer door opening, in feet
ΔkWh/ft	= Annual electric energy savings per foot of door opening
$EFLH_{cooling}$	= Cooling equivalent full-load hours
$EFLH_{heating}$	= Heating equivalent full-load hours
COP_{ref}	= Coefficient of performance of refrigeration equipment
COP_{HVAC}	= Coefficient of performance of heating, ventilation, and cooling equipment
Eff	= Gas heating system efficiency
CF	= Coincidence factor

3,412 = Conversion factor, one kWh equals 3,412 BTU
8,760 = Hours in one year
100,000 = Conversion factor, (BTU/therm), one therm equals 100,000 BTU's

Summary of Variables and Data Sources

Variable	Value	Notes
ft_{door}		From application.
ΔkWh/ft	High-Efficiency Doors on Cooler: 477 High-Efficiency Doors on Freezer: 538 Standard Doors on Cooler: 183 Standard Doors on Freezer: 392	Use defaults, based on the door type.[1]
$EFLH_{heating}$		From application. If unknown, look up based on building type, system type and location from Appendix G.
$EFLH_{cooling}$		From application. If unknown, look up based on building type, system type and location from Appendix G.
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. [2]
COP_{HVAC}	Grocery Store: 2.93 Other: 3.57	From application; COP = EER/3.412. If unknown, use default values provided based on facility type.[3]
Eff	0.80	From application. E_c, E_t or AFUE shall be used, based on nameplate rating metric of existing equipment. If unknown, use default value provided.[4]
CF	1.0	

[1] Fricke, Brian and Becker, Bryan, "Energy Use of Doored and Open Vertical Refrigerated Display Cases". Energy savings of high efficiency doors are calculated by eliminating anti-condensation heater energy draw and proportionally reducing associated work required from the refrigeration equipment while assuming an HVAC system COP of 3.28, refrigeration COP of 3.03 for coolers and 1.66 for freezers. Measured energy savings on medium temperature units was adjusted with $COP_{cooler}/COP_{freezer}$ ratios to develop savings for standard doors installed on freezer units.
[2] Based on CDH Energy evaluation of actual refrigeration system performance for several commercially available compressors, dated 09/06/2017. Values presented reflect average efficiencies of 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).
[3] ASHRAE 90.1 2010 Standard for Unitary HVAC: Grocery Store default assumes a 25-ton packaged RTU (cooling only); Other default assumes a 10-ton packaged RTU (cooling only)
[4] ASHRAE 90.1 2010 Standard for natural gas hot water boilers, 300-2,500 MBH

Coincidence Factor (CF)

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

Baseline Efficiencies from which Savings are Calculated

The baseline condition is an existing open vertical refrigerated display case.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a vertical refrigerated display case fitted with glass doors. Doors may be standard doors operating with anti-condensation heaters or high efficiency doors with advanced technology operating without anti-condensation heaters.

Operating Hours

Doored refrigerated display cases are assumed to be operating 8,760 hours per year.

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in heat transfer between the refrigerated case and the ambient air will result in reduction in space heating requirements. This impact is included in this methodology.

Ancillary Electric Savings Impacts

Retrofitting open display cases with doors may lead to the requirement of additional lighting to maintain visibility of products. The load of additional lighting was considered in this analysis.

Reduction in heat transfer between the refrigerated case and the ambient air will result in an increase in cooling requirements. This impact is included in this methodology.

References

1. Fricke, Brian and Becker, Bryan, "Energy Use of Doored and Open Vertical Refrigerated Display Cases" (2010). International Refrigeration and Air Conditioning Conference. Paper 1154.
   Available from: http://docs.lib.purdue.edu/iracc/1154ADM

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

2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2010
   Available from: https://www.ashrae.org/technical-resources/standards-andguidelines/read-only-versions-of-ashrae-standards

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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	Clothes Washer	Residential	11	DEER 2014 EUL ID: Appl-EffCW
	Clothes Dryer	Residential	14	ENERGY STAR® M&I Scoping Report[1]
	Dehumidifier	Residential	12	ENERGY STAR® Calc[2]
	Air Purifier (Cleaner)	Residential	9	ENERGY STAR® Calc[3]
	Dishwasher	Residential	11	DEER 2014 EUL ID: Appl-EffDW
	Refrigerator and Freezer Replacement	Residential	14	DEER 2014 EUL ID: Appl-ESRefg
	Soundbar	Residential	7	RPP Product Analysis[4]
Appliance Control	Advanced Power Strips	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 Leakage Sealing	Residential	15	GDS[5]
	Hot Water and Steam Pipe Insulation	Residential	15	GDS[6]
	Opaque Shell Insulation	Residential	25	GDS[7]

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

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Building Shell	Window & Through-the-Wall Air Conditioner Cover and Gap Sealer	Residential	5	See note below[8]
	Window Replacement	Residential	20	DEER 2014 EUL ID: BS-Win
Domestic Hot Water	Heat Pump Water Heater (HPWH) – Air Source [9]	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[10]
	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	Faucet – Low-Flow Aerator	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Thermostatic Shower Restriction Valve	Residential	10	UPC[11]
	Shower Head – Low Flow	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Drain Water Heat Recovery	Residential	30	2019 Title 24[12]
Heating, Ventilation and Air Conditioning (HVAC)	Refrigerant Charge Correction & Tune-Up – Air Conditioner and Heat Pump	Residential	10	DEER 2014 EUL ID: HV-RefChrg
	Air Conditioner – Central (CAC)	Residential	15	DEER 2014 EUL ID: HV-ResAC
	Air Conditioner – Room (RAC)	Residential	12	GDS[13]

[8] At least one manufacturer's warranty period. www.gss-ee.com/products.html
[9] Electric heat pump used for service hot water heating
[10] 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
[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] 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
[13] 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)	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 Tune-Up	Residential	5	DEER 2014 EUL ID: BlrTuneup
	Circulator Pump – with Electronically Commutated (EC) Motor for Hydronic Distribution	Residential	15	DEER 2014 EUL ID: Motors-pump
	Combination ("Combi") Boiler and Furnace	Residential	20	DEER[14]
	Duct Sealing and Insulation	Residential	18	DEER 2014 EUL ID: HV-DuctSeal
	Blower Fan - with Electronically Commutated (EC) Motor for HVAC Distribution	Residential	15	DEER 2014 EUL ID: Motors-fan
	Furnace, Gas Fired	Residential	22	DOE[15,16]
	Furnace Tune-Up	Residential	5	DEER 2014 EUL ID: BlrTuneup
	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
	Unit Heater, Gas Fired	Residential	13	ASHRAE Handbook, 2015

[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 Traps Repair or Replace	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]
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 Lamps (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 Lamps (Decorative & Omnidirectional)	Residential/ Multifamily Common Area	15,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Lamps

[18] NYSERDA Residential Electric Submetering Manual

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

[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 Pumps		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]
	Electric & Gas 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]
	Refrigerators & Freezers	C&I	12	DEER 2014 EUL ID: Cook-SDRef
	Ice Maker	C&I	10	DEER 2014 EUL ID: Cook-IceMach
Appliance - Control	Tier 1 Advanced Power Strips	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 (Window)	C&I	9	DEER 2014 EUL ID: HV-RAC-ES
Building Shell	Cool Roof	C&I	15	DEER 2014 EUL ID: BldgEnv-CoolRoof
	Hot Water and Steam Pipe Insulation	C&I	15	GDS[31]
	Window - Film	C&I	10	DEER 2014 EUL ID: GlazDaylt-WinFilm
	Window - Glazing	C&I	20	DEER 2014 EUL ID: BS-Win
	Opaque Shell Insulation	C&I	30	ET & CEC[32]
Compressed Air	Air Compressor	C&I	13	Other State TRMs[33]
	Air Dryer - Refrigerated	C&I	15	UI and CL&P[34]
	Engineered Air Nozzle	C&I	15	Wisconsin PSC[35]

[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] UI and CL&P, Program Savings Documentation for 2007 Program Year, September 2006, pg. 224
[35] 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[36]
Domestic Hot Water (DHW)	Domestic Hot Water Tank Blanket	C&I	7	DEER
	Indirect Water Heater	C&I	15	DEER 2014 EUL ID: WtrHt-Com
	Storage Tank Water Heater	C&I	15	DEER 2014 EUL ID: WtrHt-Com
	Instantaneous Water Heater	C&I	20	DEER 2014 EUL ID: WtrHt-Instant-Com
	Heat Pump Water Heater - Air Source (HPWH)	C&I	10	DEER
DHW - Control	Faucet – Low-Flow Aerator	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Low-Flow Salon Valves	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Showerhead – Low-Flow	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Low-Flow Pre-Rinse Spray Valve	C&I	5	GDS
Heating, Ventilation and Air Conditioning (HVAC)	Refrigerant Charge Correction & Tune Up – CAC and ASHP	C&I	10	DEER 2014 EUL ID: HVAC-RefChg
	Air Conditioner – Unitary	C&I	15	DEER 2014 EUL ID: HVAC-airAC
	Air Conditioner – PTAC	C&I	15	DEER 2014 EUL ID: HVAC-PTAC
	Chiller – Air & Water Cooled	C&I	20	DEER 2014 EUL ID: HVAC-Chlr
	Chiller – Cooling Tower	C&I	15	DEER 2014 EUL ID: HVAC-ClTwrPkgSys
	Chiller System Tune-Up	C&I	5	WI EUL DB[37]
	Combination (“Combi”) Boilers and Furnaces	C&I	20	DEER[38]
	Condensing Unit Heater	C&I	18	Ecotope[39]
	Duct Sealing and Insulation	C&I	18	DEER 2014 EUL ID: HVAC-DuctSeal
	Blower Fan – with Electronically Commutated (EC) Motor for HVAC Distribution	C&I	15	DEER 2014 EUL ID: Motors-Fan
	Economizer – Air Side, with Dual Enthalpy Control	C&I	10	DEER 2014 EUL ID: HVAC-addEcono

[36] 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
[37] Wisconsin Public Service Commission: Equipment Useful Life Database, 2013
Excerpt available from: https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[38] Based on DEER value for high efficiency boiler and instantaneous water heater
[39] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003)

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	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
	Boiler Tune-Up	C&I	5	DEER 2014 EUL ID: BlrTuneup
	Furnace, Gas Fired	C&I	23	DOE[40],[41]
	Unit Heater, Gas Fired	C&I	13	ASHRAE Handbook, 2015
	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
	Water Source Heat Pumps	C&I	25	ASHRAE[42]
	Variable Refrigerant Flow	C&I	15	DEER 2014 EUL ID: HVAC-VSD-pump
	Infrared Heater	C&I	17	GDS[43]
HVAC - Control	Thermostat – Programmable Thermostat – Wi-Fi (Communicating)	C&I	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve	C&I	15	DOE[44]
	Outdoor Temperature Setback Control for Hydronic Boilers	C&I	EUL = RUL of Existing Boiler = Boiler EUL – (Current Year – Year of Mfr.)	N/A
	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

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

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
HVAC – Control	Guest Room Energy Management System	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Steam Traps Repair/Replace	C&I	6	DEER 2014 EUL ID: HVAC-StmTrp
Lighting	CFL Lamp	C&I	9,000 hours /annual lighting operating hours	See note below[45]
	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[46] EUL ID: ILtg-Lfluor-Elec
	LED Fixtures (other than refrigerated case)	C&I	50,000 hours /annual lighting operating hours or 20 years (whichever is less)	DLC[47]
			35,000 hours /annual lighting operating hours or 20 years (whichever is less)	ENERGY STAR®[48]
			25,000 hours /annual lighting operating hours or 20 years (whichever is less)	Uncertified
	Refrigerated Case LED	C&I	16	DEER 2014 EUL ID: GrocDisp-FixtLtg-LED

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

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

[47] 50,000 hours per L_{70} requirements prescribed by the DLC's Product Qualification Criteria, Technical Requirement Table version 4.2

[48] 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

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting	LED Screw-In Lamps	C&I	15,000 hours (decorative) or 25,000 hours (all other)/ annual lighting operating hours or 20 years (whichever is less)	ENERGY STAR®
Lighting - Control	Interior Lighting Control	C&I	10	GDS[49]
	Bi-Level Lighting	C&I	15	ComEd[50]
	Plug-Load Occupancy Sensor	C&I	8	DEER[51]
Motors and Drives	Motor Replacement	C&I	15	DEER 2014 EUL ID: Motors-HiEff
	Variable Frequency Drive – Fan and Pump	C&I	15	DEER 2014 EUL ID: HVAC-VSDSupFan
Other	Pool Heater	C&I	8	DOE[52]
Process Equipment	Steam Trap Repair or Replace – 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
	Equipment (Condensers, Compressors, and Sub-cooling)	C&I	15	DEER
	Evaporator Fan Motor – with Electronically Commutated (EC) Motor for Refrigerated Case and Walk-In Cooler	C&I	15	DEER 2014 EUL ID: GrocDisp-FEvapFanMtr
	Refrigerated Case Night Cover	C&I	5	DEER 2014 EUL ID: GrocDisp-DispCvrs
	Refrigerated Case Doors	C&I	12	DEER 2014 EUL ID: GrocDisp-FixtDoors
	Auto/Fast Close Door Walk-In Coolers/Freezers	C&I	8	DEER
	Freezer and Cooler Door Gaskets	C&I	4	DEER 2014 EUL ID: GrocWlkIn-StripCrtn, GrocWlkIn-WDrGask

[49] 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

[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] DEER value for lighting occupancy sensors

[52] 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	Freezer and Cooler Door Strip	C&I	4	DEER 2014 EUL ID: GrocWlkIn-StripCrtn, GrocWlkIn-WDrGask
Refrigeration - Control	Anti-Condensation Heater Control	C&I	12	DEER 2014 EUL ID: GrocDisp-ASH
	Evaporator Fan Control	C&I	16	DEER 2014 EUL ID: Groc-WlkIn-WEvapFMtrCtrl
	Condenser Pressure and Temperature Controls	C&I	15	DEER

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

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