Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
9-19-1	R	9/27/2019	1/1/2021	R/MF Window	Updated Measure Description to clarify definition; Restricted measure to windows between conditioned and unconditioned spaces; Removed HVAC and window efficiency participant population average ratios from algorithm; Revised variable terms and definitions for consistency with other measures; Remodeled Unit Energy and Demand Savings and included within measure; Updated Baseline Efficiency, Compliance Efficiency, and Operating Hours based on model software, default assumptions, and applicability	Pg. 68
9-19-3	R	9/27/2019	1/1/2021	C/I Vending Machine and Novelty Cooler Control	Updated Measure Description to include the installation of controls on non-refrigerated vending machines; Added savings equation and default values for Non Refrigerated (Snack) Vending Machines; Updated algorithm, variable terms and definition to include control type factor and Energy Savings Factor to better represent off hours per year for occupancy sensors; Changed Summer Peak Coincident Demand Savings from N/A to negligible; Updated Operating Hours off hours derivation for occupancy sensors	Pg. 258
9-19-4	R	9/27/2019	1/1/2021	C/I Window – Film	Revised variable terms and definitions for consistency with other measures; Updated Coincidence Factor with delineation between NYC and the rest of NY State for consistency with other measures; Revised Operating Hours for consistency with other measures	Pg. 277

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
9-19-5	R	9/27/2019	1/1/2021	C/I Window – Glazing	Added detail to Measure Description; Removed window efficiency participant population average ration from algorithm; Revised variable terms and definitions for consistency with other measures; Added detail to Compliance Efficiency section	Pg. 280
9-19-6	R	9/27/2019	1/1/2021	C/I Energy Management System (EMS) – Guest Room	Updated Measure Description to include networked front desk controlled systems with individual guest room controls and to remove NYC restriction; Corrected HVAC type in unit savings tables; Updated Compliance Efficiency section to include networked front desk controlled systems with controls in individual guest rooms and to remove NYC restriction	Pg. 415
9-19-8	R	9/27/2019	1/1/2021	C/I Refrigerated Case Door	Revised algorithm, variable terms, and definition hours to capture facility HVAC system load hours; Corrected High-Efficiency Doors on Freezer default unit savings; Removed coefficient of performance defaults; Updated Operating Hours to explain derivation of HVAC system load hours and added default table	Pg. 481
9-19-9	R	9/27/2019	1/1/2021	Appendix F	Removed residential default tables	Pg. 657
9-19-10	R	9/27/2019	1/1/2021	Appendix P	Updated EUL entries for all measures contained in this Record of Revision	Pg. 765

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between June 29, 2019 – September 27, 2019.

BUILDING SHELL

WINDOW

Measure Description

This measure covers the installation of high efficiency windows with reduced thermal conductance and solar heat gain coefficient. For the purposes of this measure, a window is defined as an assembled unit consisting of a frame/sash component holding one or more pieces of glazing functioning to admit light and/or air into an enclosure and designed for a vertical installation in an external wall of a residential building.[1] This measure is only applicable to windows that serve as a barrier between conditioned spaces and outside air.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = \frac{SF}{100} \times (\Delta therms/100\ SF)$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
SF	= Total glazing area of installed windows (ft^2)
(ΔkWh/100 SF)	= Annual electricity energy savings per 100 SF of window glazing area
(ΔkW/100 SF)	= Peak coincident demand electric savings per 100 SF of window glazing area
(Δtherms/100 SF)	= Annual gas energy savings per 100 SF of window glazing area
100	= Conversion from SF to 100 SF
CF	= Coincidence Factor

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

Summary of Variables and Data Sources

Variable	Value	Notes
SF		From application
(ΔkWh/100 SF)		Lookup from table below based on City, Baseline Window and HVAC System. For window replacement, existing conditions shall be used to determine Baseline Window and HVAC System. If HVAC system type is not known, assume a Code baseline window and AC w/ Gas Heat.
(ΔkW/100 SF)		Lookup from table below based on City, Baseline Window and HVAC System. For window replacement, existing conditions shall be used to determine Baseline Window and HVAC System. If HVAC system type is not known, assume a Code baseline window and AC w/ Gas Heat.
(Δtherms/100 SF)		Lookup from table below based on City, Baseline Window and HVAC System. For window replacement, existing conditions shall be used to determine Baseline Window and HVAC System. If HVAC system type is not known, assume a Code baseline window and AC w/ Gas Heat.
CF	0.69	

Unit Energy and Demand Savings

Unit energy and demand savings were derived using LBNL's RESFEN V6.0 software. For additional detail on the derivation of these values, refer to the "NY TRM Residential Window Supplement.xlsx" workbook.

City	Baseline Window	HVAC System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	Single-Pane	AC w/ Gas Heat	133	0.29	74.3
		Heat Pump	855	0.29	0.0
		AC w/ Resistance Heat	1,578	0.29	0.0
		Gas Heat Only	0	0.00	74.3
		Resistance Heat Only	1,445	0.00	0.0
	Double-Pane	AC w/ Gas Heat	116	0.21	21.8
		Heat Pump	347	0.21	0.0
		AC w/ Resistance Heat	578	0.21	0.0
		Gas Heat Only	0	0.00	21.8
		Resistance Heat Only	463	0.00	0.0
	Code	AC w/ Gas Heat	39	0.06	1.3
		Heat Pump	62	0.06	0.0
		AC w/ Resistance Heat	86	0.06	0.0
		Gas Heat Only	0	0.00	1.3
		Resistance Heat Only	47	0.00	0.0

City	Baseline Window	HVAC System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Binghamton	Single-Pane	AC w/ Gas Heat	74	0.33	82.6
		Heat Pump	894	0.33	0.0
		AC w/ Resistance Heat	1,714	0.33	0.0
		Gas Heat Only	0	0.00	82.6
		Resistance Heat Only	1,640	0.00	0.0
	Double-Pane	AC w/ Gas Heat	68	0.24	24.1
		Heat Pump	328	0.24	0.0
		AC w/ Resistance Heat	587	0.24	0.0
		Gas Heat Only	0	0.00	24.1
		Resistance Heat Only	519	0.00	0.0
	Code	AC w/ Gas Heat	22	0.08	1.6
		Heat Pump	49	0.08	0.0
		AC w/ Resistance Heat	76	0.08	0.0
		Gas Heat Only	0	0.00	1.6
		Resistance Heat Only	54	0.00	0.0
Buffalo	Single-Pane	AC w/ Gas Heat	115	0.32	78.6
		Heat Pump	868	0.32	0.0
		AC w/ Resistance Heat	1,622	0.32	0.0
		Gas Heat Only	0	0.00	78.6
		Resistance Heat Only	1,507	0.00	0.0
	Double-Pane	AC w/ Gas Heat	102	0.23	24.1
		Heat Pump	346	0.23	0.0
		AC w/ Resistance Heat	590	0.23	0.0
		Gas Heat Only	0	0.00	24.1
		Resistance Heat Only	488	0.00	0.0
	Code	AC w/ Gas Heat	34	0.07	2.0
		Heat Pump	62	0.07	0.0
		AC w/ Resistance Heat	89	0.07	0.0
		Gas Heat Only	0	0.00	2.0
		Resistance Heat Only	55	0.00	0.0

City	Baseline Window	HVAC System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Massena	Single-Pane	AC w/ Gas Heat	106	0.29	85.4
		Heat Pump	1,181	0.29	0.0
		AC w/ Resistance Heat	2,256	0.29	0.0
		Gas Heat Only	0	0.00	85.4
		Resistance Heat Only	2,150	0.00	0.0
	Double-Pane	AC w/ Gas Heat	91	0.21	25.4
		Heat Pump	445	0.21	0.0
		AC w/ Resistance Heat	798	0.21	0.0
		Gas Heat Only	0	0.00	25.4
		Resistance Heat Only	707	0.00	0.0
	Code	AC w/ Gas Heat	29	0.06	1.8
		Heat Pump	71	0.06	0.0
		AC w/ Resistance Heat	112	0.06	0.0
		Gas Heat Only	0	0.00	1.8
		Resistance Heat Only	83	0.00	0.0
NYC	Single-Pane	AC w/ Gas Heat	155	0.32	55.8
		Heat Pump	613	0.32	0.0
		AC w/ Resistance Heat	1,072	0.32	0.0
		Gas Heat Only	0	0.00	55.8
		Resistance Heat Only	918	0.00	0.0
	Double-Pane	AC w/ Gas Heat	131	0.22	13.4
		Heat Pump	252	0.22	0.0
		AC w/ Resistance Heat	373	0.22	0.0
		Gas Heat Only	0	0.00	13.4
		Resistance Heat Only	242	0.00	0.0
	Code	AC w/ Gas Heat	41	0.07	4.7
		Heat Pump	83	0.07	0.0
		AC w/ Resistance Heat	125	0.07	0.0
		Gas Heat Only	0	0.00	4.7
		Resistance Heat Only	84	0.00	0.0

City	Baseline Window	HVAC System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Poughkeepsie	Single-Pane	AC w/ Gas Heat	144	0.30	65.1
		Heat Pump	734	0.30	0.0
		AC w/ Resistance Heat	1,325	0.30	0.0
		Gas Heat Only	0	0.00	65.1
		Resistance Heat Only	1,181	0.00	0.0
	Double-Pane	AC w/ Gas Heat	123	0.21	17.6
		Heat Pump	300	0.21	0.0
		AC w/ Resistance Heat	476	0.21	0.0
		Gas Heat Only	0	0.00	17.6
		Resistance Heat Only	352	0.00	0.0
	Code	AC w/ Gas Heat	40	0.07	3.0
		Heat Pump	73	0.07	0.0
		AC w/ Resistance Heat	106	0.07	0.0
		Gas Heat Only	0	0.00	3.0
		Resistance Heat Only	66	0.00	0.0
Syracuse	Single-Pane	AC w/ Gas Heat	110	0.25	76.0
		Heat Pump	871	0.25	0.0
		AC w/ Resistance Heat	1,633	0.25	0.0
		Gas Heat Only	0	0.00	76.0
		Resistance Heat Only	1,524	0.00	0.0
	Double-Pane	AC w/ Gas Heat	93	0.19	22.7
		Heat Pump	336	0.19	0.0
		AC w/ Resistance Heat	579	0.19	0.0
		Gas Heat Only	0	0.00	22.7
		Resistance Heat Only	486	0.00	0.0
	Code	AC w/ Gas Heat	30	0.06	1.7
		Heat Pump	56	0.06	0.0
		AC w/ Resistance Heat	83	0.06	0.0
		Gas Heat Only	0	0.00	1.7
		Resistance Heat Only	53	0.00	0.0

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.69.[2]

[2] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by the Mid-Atlantic TRM Version 6.0 published May 2016. MD factor used as approximation for NY-specific value.

Baseline Efficiencies from which Energy Savings are Calculated

Unit energy and demand savings are presented for three baseline window types and five HVAC system types for each city. The characteristics of each baseline window, HVAC system type and prototype housing model were determined using defaults presented in LBNL's RESFEN V6.0 software and applying a methodology consistent with that used by ENERGY STAR® to determine impacts of high-efficiency window installations.[3] For additional detail on inputs and assumptions used to derive the per unit savings values tabulated above, refer to the "NY TRM Residential Window Supplement.xlsx" workbook.

For window replacement, existing conditions shall be used to determine Baseline Window and HVAC System types. For New Construction and Time-of-Sale, assume a Code baseline window and AC w/ Gas Heat.

Compliance Efficiency from which Incentives are Calculated

Installed windows must meet the minimum compliance criteria required by V6.0 of the ENERGY STAR® Residential Windows, Doors and Skylights Product Specification.[4] Installed window specifications assumed for derivation of unit energy and demand savings are as follows:

U-Value: 0.27 BTU/h-ft^2-°F
Solar Heat Gain Coefficient (SHGC) = 0.32
Air Leakage: 0.3 CFM/ft^2

Operating Hours

Unit energy and demand savings depend on assumed hours of operation of the home's HVAC system. These operating hours assumptions are embedded in the RESFEN prototype models used to derive energy and demand savings values. See the "NY TRM Residential Window Supplement.xlsx" workbook and RESFEN V6.0 User's Manual for additional detail.[5]

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

[3] Methodology for ENERGY STAR® Savings Estimates for Windows (https://www.energystar.gov/products/building_products/residential_windows_doors_and_skylights/methodology_energy_star_savings_estimates_windows)
[4] ENERGY STAR® Product Specification Residential Windows, Doors, and Skylights, Eligibility Criteria, V6.0, January 2014
[5] LBNL RESFEN6 for Calculating the Heating and Cooling Energy Use of Windows in Residential Buildings, December 2012

References

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   Available from:
   https://www.energystar.gov/sites/default/files/ES_Final_V6_Residential_WDS_Spec.pdf
2. BG&E: Development of Residential Load Profile for Central Air Conditioners and Heat Pumps, via *Mid-Atlantic Technical Reference Manual Version 9.0*, October 2019 (accessed September 6, 2019)
   Available from: http://www.neep.org/mid-atlantic-technical-reference-manual-v6
3. Methodology for ENERGY STAR® Savings Estimates for Windows
   Available from:
   https://www.energystar.gov/products/building_products/residential_windows_doors_and_skylights/methodology_energy_star_savings_estimates_windows
4. LBNL RESFEN6 for Calculating the Heating and Cooling Energy Use of Windows in Residential Buildings, December 2012
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Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
6-17-1	6/30/2017
9-19-1	9/27/2019

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APPLIANCE – CONTROL

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 reduce compressor run time and lighting hours while ensuring units maintain desired product temperatures during occupied hours. 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.[6] This measure is only applicable to vending machines and novelty coolers containing non-perishable products.

This measure also covers the installation of time clocks or occupancy sensors on non-refrigerated (snack) vending machines. In this case, savings are derived from a reduction in lighting hours during unoccupied hours.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

Refrigerated Vending Machine and Novelty Cooler

$$\Delta kWh = units \times (kW/unit) \times \left[hrs_{off} + F_{control} \times ESF \times \left(8{,}760 - hrs_{off}\right)\right] \times Cycle$$

Non-Refrigerated (Snack) Vending Machine

$$\Delta kWh = units \times (kW/unit) \times \left[hrs_{off} + F_{control} \times ESF \times \left(8{,}760 - hrs_{off}\right)\right]$$

Summer Peak Coincident Demand savings

$$\Delta kW = Negligible$$

[6] 10 CFR 431 Subpart Q, Appendix B 1.2 Definitions

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
$F_{control}$	= Control type factor, used to include additional savings for occupancy sensor controls
ESF	= Energy Savings Factor, associated with occupancy sensor controls
Cycle	= Compressor duty cycle
8,760	= Hours in one year

Summary of Variables and Data Sources

Variable	Value	Notes
(kW/unit)	Refrigerated Vending Machine and Novelty Cooler: $= \frac{Volts \times Amps \times \sqrt{Phase} \times PF}{1{,}000}$ Non-Refrigerated (Snack) Vending Machine: 0.02	Refrigerated vending machine and novelty cooler power is based on nameplate Volts, Amps, Phase and Power Factor. If power factor is unknown, use a default value of 0.55.[7] Non-refrigerated machine power reflects typical per unit lighting wattage.[8]
hrs_{off}		From application. Off hours are equivalent to daily facility closed hours minus one multiplied by facility operating days. If building operating hours are unknown, look up in Operating Hours section below based on facility type. hrs_{off} is equivalent for time clock and occupancy sensor controls.
$F_{control}$		Use a value of 1.0 if Occupancy Sensor control type. Use a value of 0 if Time Clock control type.

[7] Analysis of Cooler Control Energy Conservation Measures: Final Report, Select Energy Services, Inc., March 2004

[8] Southern California Edison, Work Paper SCE17CS005 Revision 1, Beverage Merchandise Controller, July 2018, pg 9

Variable	Value	Notes
ESF	0.1	Energy savings of occupancy sensing control during building operating hours, estimated from lighting occupancy sensor controls in open office space[9]
Cycle	0.45	Compressor average duty cycle. [10]

Coincidence Factor (CF)

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

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a 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.

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

[9] DOE, Wireless Sensors for Lighting Energy Savings, March 2016, page 1
[10] Ibid, Table 5-5

Facility Type	hrs_{off} (hrs/yr)	Facility Type	hrs_{off} (hrs/yr)
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

With occupancy sensor control, units shut off after a period of time of consistent inoccupancy. The cumulative annual off hours are estimated by summing time clock control off hours and 10% of remaining on hours, as outlined in the equations above. hrs_{off} for occupancy sensors shall come from application or lookup in table above if unknown.

Effective Useful Life (EUL)

See Appendix P.

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. Sothern California Edison, Workpaper SCE17CS005, Revision 1, Beverage Merchandise Controller, July 23, 2018
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5. Department of Energy, Wireless Sensors for Lighting Energy Savings, Wireless Occupancy Sensors for Lighting Controls: An Applications Guide for Federal Facility Managers, March 2016
   Available from:
   https://www.energy.gov/sites/prod/files/2017/01/f34/wireless_occupancy_sensor_guide.pdf
6. Analysis of NREL Cold-Drink Vending Machines for Energy Savings, NREL, June 2003
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1	10/15/2010
6-18-7	6/26/2018
3-19-8	3/29/2019
9-19-3	9/27/2019

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BUILDING SHELL

WINDOW - FILM

Measure Description

This measure covers the installation of window films with reduced solar heat gain coefficient applied to single pane clear glass. Windows with lower solar heat gain coefficient lead to less required cooling loads within a conditioned space.

Due to negative impacts on space heating, this measure is applicable to buildings with electric AC and gas heat only. This measure is applicable to uncovered, single pane clear glass windows in existing buildings only.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = \frac{SF}{100} \times (\Delta therms/100\ SF)$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
SF	= Total aperture area of window glazing treated (ft^2)
(ΔkWh/100 SF)	= Annual electricity energy savings per 100 SF of window glazing area
(ΔkW/100 SF)	= Peak coincident demand electric savings per 100 SF of window glazing area
(Δtherms/100 SF)	= Annual gas energy savings per 100 SF of window glazing area
CF	= Coincidence factor
100	= Conversion to 100 square feet

Summary of Variables and Data Sources

Variable	Value	Notes
SF		From application.
ΔkWh/100 SF		Lookup based on building type and location from the Window Film section of Appendix F.
ΔkW/100 SF		Lookup based on building type and location from the Window Film section of Appendix F.
Δtherm/100 SF		Lookup based on building type and location from the Window Film section of Appendix F.
CF	NYC: 0.822 Rest of NY State: 0.477	

Unit energy and demand savings were calculated from a DOE-2.2 simulation of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The unit energy and demand savings by building types across different cities in NY are shown in the Window Film section of Appendix F.

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is 0.822 for NYC and 0.477 throughout the rest of NY state.[11]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is an existing, untreated, single pane clear glass window with an assumed solar heat gain coefficient of 0.87 and U-value of 1.2 BTU/h- ft^2- ^oF.[12]

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an existing window with added film with a solar heat gain coefficient of 0.40 or less.

Operating Hours

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

[11] C&I Unitary HVAC Load Shape Project Final Report, KEMA, 2011, Table 0-5: NY - Inland and NY - Urban/Coastal
[12] ASHRAE 2013 Handbook of Fundamentals

Ancillary Electric Savings Impacts

N/A

References

1. ASHRAE 2013 Handbook of Fundamentals by American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). Atlanta, GA, 2013.
2. *C&I Unitary HVAC Load Shape Project Final Report*, KEMA, August 2, 2011, Table 0-5; (accessed March 21, 2017).
   Available from:
   http://www.neep.org/sites/default/files/resources/NEEP_HVAC_Load_Shape_Report_Final_August2.pdf

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1	10/15/2010
9-18-10	9/28/2018
9-19-4	9/27/2019

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WINDOW - GLAZING

Measure Description

This measure covers the installation of high efficiency windows with reduced thermal conductance and solar heat gain coefficient. For the purposes of this measure, a window is defined as an assembled unit consisting of a frame/sash component holding one or more pieces of glazing functioning to admit light and/or air into an enclosure and designed for a vertical installation in an external wall of a commercial building.[13]

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Summer Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

where:

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

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

100 = Conversion from SF to 100 SF

Summary of Variables and Data Sources[14]

Variable	Value	Notes
SF		From application
(ΔkWh/100 SF)		Lookup from Appendix F based on Facility Type, City and HVAC System.
(ΔkW/100 SF)		Lookup from Appendix F based on Facility Type, City and HVAC System.
(Δtherms/100 SF)		Lookup from Appendix F based on Facility Type, City and HVAC System.
$EER_{baseline}$	11.2	EER used in the simulations[15]
EER_{part}		EER of cooling systems within participant population, defaults to $EER_{baseline}$ (no adjustment)
$SEER_{baseline}$	14	SEER used in the simulations[16]
$SEER_{part}$		SEER of cooling system within participant population, defaults to $SEER_{baseline}$ (no adjustment)
$Eff_{baseline}$	0.80	Efficiency (AFUE) used in the simulations[17]
Eff_{part}		Efficiency (AFUE, E_t, or E_c) of heating system within participant population, defaults to $Eff_{baseline}$ (no adjustment)
CF	NYC: 0.822 Rest of NY State: 0.477	

Unit energy and demand savings calculated from the building prototype simulation models are shown in Appendix F. The savings are tabulated by location, building type, and HVAC system type for a variety of combinations of existing window and improved window types.

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is 0.822 for NYC and 0.477 throughout the rest of NY State.[18]

Baseline Efficiencies from which Energy Savings are Calculated

A variety of existing window combinations are shown in the unit savings tables, including single pane clear glass, double pane clear glass and a minimally code compliant window. Energy savings are estimated based on the characteristics of the existing window. Single pane clear glass is the

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

default for the old vintage, while double pane clear glass is the default for the average vintage. The minimally code compliant window shall be the base case for new construction or window replacement projects.

Compliance Efficiency from which Incentives are Calculated

The minimum compliance condition for this measure is a window meeting the current ENERGY STAR® specifications. These specifications, which are used to derive savings prescribed by this measure, are listed below[19]:

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

Operating Hours

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. ENERGY STAR® Product Specification Residential Windows, Doors, and Skylights, Eligibility Criteria, Version 6.0, January 2014
   Available from:
   https://www.energystar.gov/sites/default/files/ES_Final_V6_Residential_WDS_Spec.pdf
2. ECCCNYS 2016, per IECC 2015; Table C403.2.3(1): Minimum Efficiency Requirements: Electrically Operated Unitary Air Conditioners And Condensing Units & Table C403.2.3(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers.
   Available from: https://codes.iccsafe.org/public/document/IECC2015NY-1/chapter-4-ce-commercial-energy-efficiency

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

3. Window properties for baseline windows taken from 2013 ASHRAE Handbook of Fundamentals Chapter 15. The 2013 ASHRAE Handbook of Fundamentals is used in the prototype simulations and therefore is not updated to the current version.
4. *C&I Unitary HVAC Load Shape Project Final Report*, KEMA, August 2, 2011, Table 0-5; (accessed March 21, 2017).
   Available from:
   http://www.neep.org/sites/default/files/resources/NEEP_HVAC_Load_Shape_Report_Final_August2.pdf

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
6-17-9	6/30/2017
9-19-5	9/27/2019

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC) - CONTROL

ENERGY MANAGEMENT SYSTEM (EMS) - GUEST ROOM

Measure Description

This measure covers the installation of guest room energy management systems that control HVAC units for individual hotel and motel rooms based upon occupancy sensors, passive infrared or key cards that indicate room occupancy. Sensors controlled by a networked front desk system must also have occupancy sensors in each guest room.[20] During unoccupied periods[21], the default setting for controlled units must differ from the operating set point by at least five degrees Fahrenheit or shut the unit fan and heating/cooling off completely. The existing (baseline) HVAC system must be manually controlled within each guest room.

The control system may also be tied into other electric loads, such as lighting and plug loads, to shut them off when occupancy is not sensed, however energy savings of additional equipment is not considered under this measure.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{tons}{unit} \times ESF_{electric}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{tons}{unit} \times DSF$$

Annual Gas Energy Savings

$$\Delta therms = units \times \frac{tons}{unit} \times ESF_{gas}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of guest rooms with energy management systems installed under the program
tons/unit	= Tons of air conditioning per unit, based on nameplate data
$ESF_{electric}$	= Electric energy savings factor (kWh/ton)

[20] A networked system controlled from the front desk is defined as a system capable of identifying reserved rooms according to a timed schedule and controlling HVAC in each guest room separately as defined by NYC Local Law 91, section C202 General Definitions

[21] An unoccupied room is defined as a guest room that has been continuously unoccupied for at least 30 minutes.

DSF = Demand savings factor (kW/ton)
ESF_{gas} = Gas energy savings factor (therms/ton)

Summary of Variables and Data Sources

Variable	Value	Notes
tons/unit		From application
$ESF_{electric}$		Lookup from $ESF_{cooling}$ table below based on location, building type, HVAC type, and instruction of housekeeping staff to manually setback prior to installation of EMS system.
DSF		Lookup from $DSF_{cooling}$ table below based on location, building type, HVAC type, and instruction of housekeeping staff to manually setback prior to installation of EMS system.
ESF_{gas}		Lookup from $ESF_{heating}$ table below based on location, building type, HVAC type, and instruction of housekeeping staff to manually setback prior to installation of EMS system.

$ESF_{electric}$[22]

kWh/ton							
Building Type, HVAC Type, Housekeeping Setback	**Albany**	**Binghamton**	**Buffalo**	**Massena**	**NYC**	**Poughkeepsie**	**Syracuse**
Motel, PTAC w/ Electric Resistance Heating, Housekeeping Setback	359	230	327	218	697	403	343
Motel, PTAC w/ Electric Resistance Heating, No Housekeeping Setback	1122	718	1022	682	2179	1261	1071
Motel, PTAC w/ Gas Heating, Housekeeping Setback	36	23	33	22	70	41	35
Motel, PTAC w/ Gas Heating, No Housekeeping Setback	116	74	105	70	225	130	110
Motel, PTHP, Housekeeping Setback	150	96	136	91	291	168	143
Motel, PTHP, No Housekeeping Setback	566	362	516	344	1099	636	540
Hotel, PTAC w/ Electric Resistance Heating, Housekeeping Setback	133	85	121	81	259	150	127
Hotel, PTAC w/ Electric Resistance Heating, No Housekeeping Setback	242	155	221	147	471	273	232
Hotel, PTAC w/ Gas Heating, Housekeeping Setback	84	54	77	51	164	95	81
Hotel, PTAC w/ Gas Heating, No Housekeeping Setback	138	88	126	84	269	155	132
Hotel, PTHP, Housekeeping Setback	103	66	94	63	200	116	98

[22] Deemed savings calculated based on IL TRM Version 7.0 values for Chicago, adjusted by the ratio of NCEI Cooling Degree Day 1981-2010 Normals for each listed NYS major city as compared to Chicago O'Hare Airport (accessed 11/26/2018). IL TRM deemed savings derived through the simulation of hotel and motel models in EnergyPlus as informed by S. Keates, ADM Associates Workpaper: "Suggested Revisions to Guest Room Energy Management (PTAC & PTHP)", 11/14/2013. This source is not publicly available but is referenced by the IL TRM Version 7.0.

kWh/ton							
Building Type, HVAC Type, Housekeeping Setback	**Albany**	**Binghamton**	**Buffalo**	**Massena**	**NYC**	**Poughkeepsie**	**Syracuse**
Hotel, PTHP, No Housekeeping Setback	177	113	162	108	344	199	169
Hotel, Central Chilled Water Fan Coil w/ Electric Resistance Heating, Housekeeping Setback	114	73	104	69	222	128	109
Hotel, Central Chilled Water Fan Coil w/ Electric Resistance Heating, No Housekeeping Setback	208	133	190	127	405	234	199
Hotel, Central Chilled Water Fan Coil w/ Gas Heating, Housekeeping Setback	65	42	59	40	127	73	62
Hotel, Central Chilled Water Fan Coil w/ Gas Heating, No Housekeeping Setback	104	67	95	63	203	117	100

DSF[23]

kW/ton							
Building Type, HVAC Type, Housekeeping Setback	**Albany**	**Binghamton**	**Buffalo**	**Massena**	**NYC**	**Poughkeepsie**	**Syracuse**
Motel, PTAC w/ Electric Resistance Heating, Housekeeping Setback	0.04	0.03	0.04	0.03	0.08	0.05	0.04
Motel, PTAC w/ Electric Resistance Heating, No Housekeeping Setback	0.12	0.08	0.11	0.07	0.23	0.14	0.12
Motel, PTAC w/ Gas Heating, Housekeeping Setback	0.04	0.03	0.04	0.03	0.08	0.05	0.04
Motel, PTAC w/ Gas Heating, No Housekeeping Setback	0.12	0.08	0.11	0.07	0.23	0.14	0.12
Motel, PTHP, Housekeeping Setback	0.04	0.03	0.04	0.03	0.08	0.05	0.04
Motel, PTHP, No Housekeeping Setback	0.12	0.08	0.11	0.07	0.23	0.14	0.12
Hotel, PTAC w/ Electric Resistance Heating, Housekeeping Setback	0.05	0.03	0.05	0.03	0.10	0.06	0.05
Hotel, PTAC w/ Electric Resistance Heating, No Housekeeping Setback	0.08	0.05	0.07	0.05	0.15	0.09	0.07
Hotel, PTAC w/ Gas Heating, Housekeeping Setback	0.05	0.03	0.05	0.03	0.10	0.06	0.05
Hotel, PTAC w/ Gas Heating, No Housekeeping Setback	0.08	0.05	0.07	0.05	0.15	0.09	0.07
Hotel, PTHP, Housekeeping Setback	0.05	0.03	0.05	0.03	0.10	0.06	0.05
Hotel, PTHP, No Housekeeping Setback	0.08	0.05	0.07	0.05	0.15	0.09	0.07

[23] Deemed savings calculated based on IL TRM Version 7.0 values for Chicago, adjusted by the ratio of NCEI Cooling Degree Day 1981-2010 Normals for each listed NYS major city as compared to Chicago O'Hare Airport (accessed 11/27/2018). IL TRM deemed savings derived through the simulation of hotel and motel models in EnergyPlus as informed by S. Keates, ADM Associates Workpaper: "Suggested Revisions to Guest Room Energy Management (PTAC & PTHP)", 11/14/2013. This source is not publicly available but is referenced by the IL TRM Version 7.0.

kW/ton							
Building Type, HVAC Type, Housekeeping Setback	**Albany**	**Binghamton**	**Buffalo**	**Massena**	**NYC**	**Poughkeepsie**	**Syracuse**
Hotel, Central Chilled Water Fan Coil w/ Electric Resistance Heating, Housekeeping Setback	0.04	0.02	0.03	0.02	0.07	0.04	0.03
Hotel, Central Chilled Water Fan Coil w/ Electric Resistance Heating, No Housekeeping Setback	0.05	0.03	0.05	0.03	0.10	0.06	0.05
Hotel, Central Chilled Water Fan Coil w/ Gas Heating, Housekeeping Setback	0.04	0.02	0.03	0.02	0.07	0.04	0.03
Hotel, Central Chilled Water Fan Coil w/ Gas Heating, No Housekeeping Setback	0.05	0.03	0.05	0.03	0.10	0.06	0.05

ESF_{gas}[24]

therms/ton							
Building Type, HVAC Type, Housekeeping Setback	**Albany**	**Binghamton**	**Buffalo**	**Massena**	**NYC**	**Poughkeepsie**	**Syracuse**
Motel, PTAC w/ Gas Heating, Housekeeping Setback	21.1	22.7	20.9	25.9	14.7	19.6	21.0
Motel, PTAC w/ Gas Heating, No Housekeeping Setback	65.3	70.3	64.7	80.2	45.7	60.7	65.0
Hotel, PTAC w/ Gas Heating, Housekeeping Setback	3.2	3.4	3.1	3.9	2.2	2.9	3.1
Hotel, PTAC w/ Gas Heating, No Housekeeping Setback	6.8	7.4	6.8	8.4	4.8	6.4	6.8
Hotel, Central Chilled Water Fan Coil w/ Gas Heating, Housekeeping Setback	3.2	3.4	3.1	3.9	2.2	2.9	3.1
Hotel, Central Chilled Water Fan Coil w/ Gas Heating, No Housekeeping Setback	6.8	7.4	6.8	8.4	4.8	6.4	6.8

Reference CDD and HDD Climate Normals[25]

Location	Cooling Degree Days (CDD)	Heating Degree Days (HDD)
Chicago (Reference)	842	6,340
Albany	597	6,680
Binghamton	382	7,193
Buffalo	544	6,617
Massena	363	8,196
New York City	1,160	4,671
Poughkeepsie	671	6,210
Syracuse	570	6,651

[24] Deemed savings calculated based on IL TRM Version 7.0 values for Chicago, adjusted by the ratio of NCEI Heating Degree Day 1981-2010 Normals for each listed NYS major city as compared to Chicago O'Hare Airport (accessed 11/27/2018). IL TRM deemed savings derived through the simulation of hotel and motel models in EnergyPlus as informed by S. Keates, ADM Associates Workpaper: "Suggested Revisions to Guest Room Energy Management (PTAC & PTHP)", 11/14/2013. This source is not publicly available but is referenced by the IL TRM Version 7.0.

[25] NOAA National Centers for Environmental Information – NCEI 1981-2010 Climate Normals

Coincidence Factor (CF)

The prescribed value for the coincidence factor is N/A. Peak coincidence is embedded into DSF values listed above.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline is a hotel or motel guest room with manual heating/cooling temperature set point, with or without instruction to the housekeeping staff to manually setback the temperature.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a hotel or motel guest room with a guest room energy management system that automatically adjusts room temperature by at least 5 degrees of operating set point based on room occupancy. Occupancy is detected by occupancy sensors or keycard sensors that automate temperature setback. Networked front desk controlled systems must also include occupancy sensors in guest rooms.

Savings are based on the guest room energy management system's ability to automatically adjust the guest room's set temperature or reduce the cycle time of the HVAC unit for various occupancy modes.

Operating Hours

Operating hours assumptions, based on heating and cooling degree days by location, are embedded into the estimated savings listed above.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

Guest room energy management systems may be connected to lighting and plug loads in addition to HVAC systems. Shutting off power to lights and plug loads may provide additional electricity savings. These potential savings are not considered in this measure.

References

1. Local Laws of the City of New York for the year 2016, No. 91, 403.2.18 Automatic control of HVAC in hotel/motel guest rooms
   Available from: https://www1.nyc.gov/assets/buildings/local_laws/ll91of2016.pdf

2. 2019 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 7.0. September 13, 2018 (accessed November 27, 2018)
Available from:
http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/Final/2019_IL-TRM_Version_7.0_dated_Sept-13-2018_Final_Volumes_1-4_Compiled.pdf
3. 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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9-19-6	9/27/2019

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REFRIGERATION

REFRIGERATED CASE DOOR

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

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

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
$hrs_{cooling}$	= Cooling HVAC load hours
$hrs_{heating}$	= Heating HVAC 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: 747 Standard Doors on Cooler: 183 Standard Doors on Freezer: 392	Use defaults, based on the door type.[26] Electric energy savings of Standard Doors do not consider anti-condensation heater controls. See Anti-Condensation Heater Control measure to claim additional savings.
$hrs_{heating}$		From application. If unknown, look up based on location and facility type in Operating Hours section below.
$hrs_{cooling}$		From application. If unknown, look up based on location and facility type in Operating Hours section below.
COP_{ref}		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.
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.[27]
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.[28]
CF	1.0	

[26] 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.
[27] 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)
[28] 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.[29]

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 HVAC system load hours shall be taken from application. If unknown, look up default values in table below based on location and facility type. Default HVAC system load hours were developed from NOAA hourly normals by assuming a 65ºF balance point temperature and summing dry bulb hours above the balance point for HVAC cooling and below the balance point for HVAC heating during building operating hours.[30] Grocery stores are assumed to operate between 7AM-10PM and other building are assumed to operate between 7AM-7PM.

City	Grocery Cooling Hours	Other Cooling Hours	Grocery Heating Hours	Other Heating Hours
Albany	1,593	1,324	3,769	2,968
Binghamton	1,254	1,051	4,109	3,251
Buffalo	1,502	1,234	3,876	3,066
Massena*	1,502	1,254	3,873	3,049
NYC	1,965	1,597	3,408	2,698
Poughkeepsie**	1,749	1,464	3,636	2,847
Syracuse	1,552	1,305	3,826	3,001

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

Effective Useful Life (EUL)

See Appendix P.

[29] *No source specified – update pending availability and review of applicable references.*
[30] NOAA National Centers for Environmental Information – NCEI 2010 Hourly Normals

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:
   https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=2153&context=iracc
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2016
   Available from: https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards
3. NOAA National Centers for Environmental Information
   Available from: https://www.ncdc.noaa.gov/cdo-web/search?datasetid=NORMAL_HLY

Record of Revision

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3-19-14	3/29/2019
9-19-8	9/27/2019

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APPENDIX F

COMMERCIAL HIGH PERFORMANCE WINDOWS

High-Performance Windows – Assembly

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	2,222	0.156	0.0
	AC with gas heat	270	0.156	86.5
	Air source heat pump	1,951	0.156	0.0
	Electric heat only	1,992	0.000	0.0
	Gas heat only	0	0.000	86.5
Binghamton	AC with electric heat	2,345	0.156	0.0
	AC with gas heat	220	0.156	96.6
	Air source heat pump	2,278	0.156	0.0
	Electric heat only	2,163	0.000	0.0
	Gas heat only	0	0.000	96.6
Buffalo	AC with electric heat	2,169	0.156	0.0
	AC with gas heat	235	0.156	88.2
	Air source heat pump	1,703	0.156	0.0
	Electric heat only	1,985	0.000	0.0
	Gas heat only	0	0.000	88.2
Massena	AC with electric heat	4,296	0.156	0.0
	AC with gas heat	304	0.156	182.9
	Air source heat pump	3,878	0.156	0.0
	Electric heat only	4,083	0.000	0.0
	Gas heat only	0	0.000	182.9
NYC	AC with electric heat	1,048	0.156	0.0
	AC with gas heat	389	0.156	30.1
	Air source heat pump	825	0.156	0.0
	Electric heat only	714	0.000	0.0
	Gas heat only	0	0.000	30.1
Poughkeepsie	AC with electric heat	2,053	0.156	0.0
	AC with gas heat	262	0.156	83.4
	Air source heat pump	1,861	0.156	0.0
	Electric heat only	1,843	0.000	0.0
	Gas heat only	0	0.000	83.4
Syracuse	AC with electric heat	1,775	0.156	0.0
	AC with gas heat	267	0.156	68.7
	Air source heat pump	1,852	0.156	0.0
	Electric heat only	1,541	0.000	0.0
	Gas heat only	0	0.000	68.7

High-Performance Windows - Big Box Retail

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,714	0.156	0.0
	AC with gas heat	294	0.156	68.9
	Air source heat pump	1,520	0.156	0.0
	Electric heat only	1,563	0.000	0.0
	Gas heat only	0	0.000	68.9
Binghamton	AC with electric heat	1,493	0.156	0.0
	AC with gas heat	223	0.156	60.4
	Air source heat pump	1,596	0.156	0.0
	Electric heat only	1,324	0.000	0.0
	Gas heat only	0	0.000	60.4
Buffalo	AC with electric heat	1,794	0.156	0.0
	AC with gas heat	250	0.156	72.5
	Air source heat pump	1,454	0.156	0.0
	Electric heat only	1,594	0.000	0.0
	Gas heat only	0	0.000	72.5
Massena	AC with electric heat	1,934	0.156	0.0
	AC with gas heat	284	0.156	78.0
	Air source heat pump	1,750	0.156	0.0
	Electric heat only	1,751	0.000	0.0
	Gas heat only	0	0.000	78.0
NYC	AC with electric heat	860	0.156	0.0
	AC with gas heat	353	0.156	25.0
	Air source heat pump	735	0.156	0.0
	Electric heat only	561	0.000	0.0
	Gas heat only	0	0.000	25.0
Poughkeepsie	AC with electric heat	1,137	0.156	0.0
	AC with gas heat	273	0.156	41.0
	Air source heat pump	916	0.156	0.0
	Electric heat only	959	0.000	0.0
	Gas heat only	0	0.000	41.0
Syracuse	AC with electric heat	1,433	0.156	0.0
	AC with gas heat	281	0.156	54.0
	Air source heat pump	1,361	0.156	0.0
	Electric heat only	1,292	0.000	0.0
	Gas heat only	0	0.000	54.0

High-Performance Windows -Fast Food Restaurant

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	2,032	0.156	0.0
	AC with gas heat	298	0.156	81.2
	Air source heat pump	1,504	0.156	0.0
	Electric heat only	1,810	0.000	0.0
	Gas heat only	0	0.000	81.2
Binghamton	AC with electric heat	2,086	0.156	0.0
	AC with gas heat	257	0.156	86.0
	Air source heat pump	1,544	0.156	0.0
	Electric heat only	1,814	0.000	0.0
	Gas heat only	0	0.000	86.0
Buffalo	AC with electric heat	2,302	0.156	0.0
	AC with gas heat	281	0.156	94.8
	Air source heat pump	1,703	0.156	0.0
	Electric heat only	1,789	0.000	0.0
	Gas heat only	0	0.000	94.8
Massena	AC with electric heat	2,158	0.156	0.0
	AC with gas heat	284	0.156	87.1
	Air source heat pump	1,597	0.156	0.0
	Electric heat only	1,845	0.000	0.0
	Gas heat only	0	0.000	87.1
NYC	AC with electric heat	1,694	0.156	0.2
	AC with gas heat	382	0.156	64.0
	Air source heat pump	1,254	0.156	0.0
	Electric heat only	1,905	0.000	0.0
	Gas heat only	0	0.000	64.0
Poughkeepsie	AC with electric heat	1,801	0.156	0.0
	AC with gas heat	308	0.156	71.9
	Air source heat pump	1,333	0.156	0.0
	Electric heat only	1,927	0.000	0.0
	Gas heat only	0	0.000	71.9
Syracuse	AC with electric heat	2,066	0.156	0.2
	AC with gas heat	303	0.156	83.1
	Air source heat pump	1,529	0.156	0.0
	Electric heat only	1,867	0.000	0.0
	Gas heat only	0	0.000	83.1

High-Performance Windows -Full Service Restaurant

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	2,670	0.156	0.0
	AC with gas heat	380	0.156	108.6
	Air source heat pump	1,976	0.156	0.0
	Electric heat only	2,426	0.000	0.0
	Gas heat only	0	0.000	108.6
Binghamton	AC with electric heat	2,778	0.156	0.0
	AC with gas heat	338	0.156	115.2
	Air source heat pump	2,056	0.156	0.0
	Electric heat only	2,614	0.000	0.0
	Gas heat only	0	0.000	115.2
Buffalo	AC with electric heat	2,977	0.156	0.0
	AC with gas heat	352	0.156	124.3
	Air source heat pump	2,203	0.156	0.0
	Electric heat only	2,751	0.000	0.0
	Gas heat only	0	0.000	124.3
Massena	AC with electric heat	2,812	0.156	0.0
	AC with gas heat	372	0.156	115.5
	Air source heat pump	2,081	0.156	0.0
	Electric heat only	2,618	0.000	0.0
	Gas heat only	0	0.000	115.5
NYC	AC with electric heat	2,325	0.156	0.0
	AC with gas heat	449	0.156	91.7
	Air source heat pump	1,721	0.156	0.0
	Electric heat only	2,068	0.000	0.0
	Gas heat only	0	0.000	91.7
Poughkeepsie	AC with electric heat	2,161	0.156	0.0
	AC with gas heat	373	0.156	87.6
	Air source heat pump	1,599	0.156	0.0
	Electric heat only	1,921	0.000	0.0
	Gas heat only	0	0.000	87.6
Syracuse	AC with electric heat	3,060	0.156	0.0
	AC with gas heat	407	0.156	127.3
	Air source heat pump	2,264	0.156	0.0
	Electric heat only	2,874	0.000	0.0
	Gas heat only	0	0.000	127.3

High-Performance Windows – Grocery

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,714	0.156	0.0
	AC with gas heat	294	0.156	68.9
	Air source heat pump	1,520	0.156	0.0
	Electric heat only	1,563	0.000	0.0
	Gas heat only	0	0.000	68.9
Binghamton	AC with electric heat	1,493	0.156	0.0
	AC with gas heat	223	0.156	60.4
	Air source heat pump	1,596	0.156	0.0
	Electric heat only	1,324	0.000	0.0
	Gas heat only	0	0.000	60.4
Buffalo	AC with electric heat	1,794	0.156	0.0
	AC with gas heat	250	0.156	72.5
	Air source heat pump	1,454	0.156	0.0
	Electric heat only	1,594	0.000	0.0
	Gas heat only	0	0.000	72.5
Massena	AC with electric heat	1,934	0.156	0.0
	AC with gas heat	284	0.156	78.0
	Air source heat pump	1,750	0.156	0.0
	Electric heat only	1,751	0.000	0.0
	Gas heat only	0	0.000	78.0
NYC	AC with electric heat	860	0.156	0.0
	AC with gas heat	353	0.156	25.0
	Air source heat pump	735	0.156	0.0
	Electric heat only	561	0.000	0.0
	Gas heat only	0	0.000	25.0
Poughkeepsie	AC with electric heat	1,137	0.156	0.0
	AC with gas heat	273	0.156	41.0
	Air source heat pump	916	0.156	0.0
	Electric heat only	959	0.000	0.0
	Gas heat only	0	0.000	41.0
Syracuse	AC with electric heat	1,433	0.156	0.0
	AC with gas heat	281	0.156	54.0
	Air source heat pump	1,361	0.156	0.0
	Electric heat only	1,292	0.000	0.0
	Gas heat only	0	0.000	54.0

High-Performance Windows – Light Industrial

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	967	0.156	0.0
	AC with gas heat	239	0.156	34.6
	Air source heat pump	838	0.156	0.0
	Electric heat only	764	0.000	0.0
	Gas heat only	0	0.000	34.6
Binghamton	AC with electric heat	1,092	0.156	0.0
	AC with gas heat	200	0.156	40.4
	Air source heat pump	875	0.156	0.0
	Electric heat only	922	0.000	0.0
	Gas heat only	0	0.000	40.4
Buffalo	AC with electric heat	1,202	0.156	0.0
	AC with gas heat	233	0.156	48.3
	Air source heat pump	923	0.156	0.0
	Electric heat only	1,050	0.000	0.0
	Gas heat only	0	0.000	48.3
Massena	AC with electric heat	1,138	0.156	0.0
	AC with gas heat	219	0.156	43.6
	Air source heat pump	980	0.156	0.0
	Electric heat only	943	0.000	0.0
	Gas heat only	0	0.000	43.6
NYC	AC with electric heat	717	0.156	0.0
	AC with gas heat	318	0.156	19.6
	Air source heat pump	613	0.156	0.0
	Electric heat only	442	0.000	0.0
	Gas heat only	0	0.000	19.6
Poughkeepsie	AC with electric heat	636	0.156	0.0
	AC with gas heat	216	0.156	19.6
	Air source heat pump	521	0.156	0.0
	Electric heat only	450	0.000	0.0
	Gas heat only	0	0.000	19.6
Syracuse	AC with electric heat	974	0.156	0.0
	AC with gas heat	219	0.156	35.2
	Air source heat pump	837	0.156	0.0
	Electric heat only	781	0.000	0.0
	Gas heat only	0	0.000	35.2

High-Performance Windows –Motel

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,828	0.156	0.0
	AC with gas heat	326	0.156	70.1
	Air source heat pump	1,478	0.156	0.0
	Electric heat only	1,572	0.000	0.0
	Gas heat only	0	0.000	70.1
Binghamton	AC with electric heat	1,863	0.156	0.0
	AC with gas heat	273	0.156	74.2
	Air source heat pump	1,580	0.156	0.0
	Electric heat only	1,636	0.000	0.0
	Gas heat only	0	0.000	74.2
Buffalo	AC with electric heat	1,977	0.156	0.0
	AC with gas heat	298	0.156	78.9
	Air source heat pump	1,489	0.156	0.0
	Electric heat only	1,714	0.000	0.0
	Gas heat only	0	0.000	78.9
Massena	AC with electric heat	2,382	0.156	0.0
	AC with gas heat	319	0.156	95.9
	Air source heat pump	2,000	0.156	0.0
	Electric heat only	2,130	0.000	0.0
	Gas heat only	0	0.000	95.9
NYC	AC with electric heat	1,243	0.156	0.0
	AC with gas heat	413	0.156	40.0
	Air source heat pump	941	0.156	0.0
	Electric heat only	953	0.000	0.0
	Gas heat only	0	0.000	40.0
Poughkeepsie	AC with electric heat	1,430	0.156	0.0
	AC with gas heat	312	0.156	53.0
	Air source heat pump	1,159	0.156	0.0
	Electric heat only	1,202	0.000	0.0
	Gas heat only	0	0.000	53.0
Syracuse	AC with electric heat	1,748	0.156	0.0
	AC with gas heat	326	0.156	66.9
	Air source heat pump	1,468	0.156	0.0
	Electric heat only	1,507	0.000	0.0
	Gas heat only	0	0.000	66.9

High-Performance Windows -Primary School

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,863	0.000	0.0
	AC with gas heat	554	0.000	57.6
	Air source heat pump	1,429	0.000	0.0
	Electric heat only	1,332	0.000	0.0
	Gas heat only	0	0.000	57.6
Binghamton	AC with electric heat	1,971	0.000	0.0
	AC with gas heat	470	0.000	66.3
	Air source heat pump	1,440	0.000	0.0
	Electric heat only	1,529	0.000	0.0
	Gas heat only	0	0.000	66.3
Buffalo	AC with electric heat	2,195	0.000	0.0
	AC with gas heat	531	0.000	74.0
	Air source heat pump	1,556	0.000	0.0
	Electric heat only	1,737	0.000	0.0
	Gas heat only	0	0.000	74.0
Massena	AC with electric heat	2,072	0.000	0.0
	AC with gas heat	518	0.000	67.7
	Air source heat pump	1,636	0.000	0.0
	Electric heat only	1,578	0.000	0.0
	Gas heat only	0	0.000	67.7
NYC	AC with electric heat	1,671	0.000	0.0
	AC with gas heat	692	0.000	44.4
	Air source heat pump	1,174	0.000	0.0
	Electric heat only	1,050	0.000	0.0
	Gas heat only	0	0.000	44.4
Poughkeepsie	AC with electric heat	1,380	0.000	0.0
	AC with gas heat	570	0.000	35.9
	Air source heat pump	1,125	0.000	0.0
	Electric heat only	780	0.000	0.0
	Gas heat only	0	0.000	35.9
Syracuse	AC with electric heat	1,958	0.000	0.0
	AC with gas heat	550	0.000	62.3
	Air source heat pump	1,468	0.000	0.0
	Electric heat only	1,438	0.000	0.0
	Gas heat only	0	0.000	62.3

High-Performance Windows -Religious Worship

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	2,222	0.156	0.0
	AC with gas heat	270	0.156	86.5
	Air source heat pump	1,951	0.156	0.0
	Electric heat only	1,992	0.000	0.0
	Gas heat only	0	0.000	86.5
Binghamton	AC with electric heat	2,345	0.156	0.0
	AC with gas heat	220	0.156	96.6
	Air source heat pump	2,278	0.156	0.0
	Electric heat only	2,163	0.000	0.0
	Gas heat only	0	0.000	96.6
Buffalo	AC with electric heat	2,169	0.156	0.0
	AC with gas heat	235	0.156	88.2
	Air source heat pump	1,703	0.156	0.0
	Electric heat only	1,985	0.000	0.0
	Gas heat only	0	0.000	88.2
Massena	AC with electric heat	4,296	0.156	0.0
	AC with gas heat	304	0.156	182.9
	Air source heat pump	3,878	0.156	0.0
	Electric heat only	4,083	0.000	0.0
	Gas heat only	0	0.000	182.9
NYC	AC with electric heat	1,048	0.156	0.0
	AC with gas heat	389	0.156	30.1
	Air source heat pump	825	0.156	0.0
	Electric heat only	714	0.000	0.0
	Gas heat only	0	0.000	30.1
Poughkeepsie	AC with electric heat	2,053	0.156	0.0
	AC with gas heat	262	0.156	83.4
	Air source heat pump	1,861	0.156	0.0
	Electric heat only	1,843	0.000	0.0
	Gas heat only	0	0.000	83.4
Syracuse	AC with electric heat	1,775	0.156	0.0
	AC with gas heat	267	0.156	68.7
	Air source heat pump	1,852	0.156	0.0
	Electric heat only	1,541	0.000	0.0
	Gas heat only	0	0.000	68.7

High-Performance Windows -Small Office

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,169	0.156	0.0
	AC with gas heat	303	0.156	43.1
	Air source heat pump	829	0.156	0.0
	Electric heat only	855	0.000	0.0
	Gas heat only	0	0.000	43.1
Binghamton	AC with electric heat	1,225	0.156	0.0
	AC with gas heat	260	0.156	48.2
	Air source heat pump	842	0.156	0.0
	Electric heat only	948	0.000	0.0
	Gas heat only	0	0.000	48.2
Buffalo	AC with electric heat	1,300	0.156	0.0
	AC with gas heat	281	0.156	51.0
	Air source heat pump	877	0.156	0.0
	Electric heat only	1,024	0.000	0.0
	Gas heat only	0	0.000	51.0
Massena	AC with electric heat	1,349	0.156	0.0
	AC with gas heat	290	0.156	51.8
	Air source heat pump	1,021	0.156	0.0
	Electric heat only	1,052	0.000	0.0
	Gas heat only	0	0.000	51.8
NYC	AC with electric heat	942	0.156	0.0
	AC with gas heat	366	0.156	29.7
	Air source heat pump	639	0.156	0.0
	Electric heat only	581	0.000	0.0
	Gas heat only	0	0.000	29.7
Poughkeepsie	AC with electric heat	860	0.156	0.0
	AC with gas heat	282	0.156	29.0
	Air source heat pump	636	0.156	0.0
	Electric heat only	517	0.000	0.0
	Gas heat only	0	0.000	29.0
Syracuse	AC with electric heat	1,201	0.156	0.0
	AC with gas heat	310	0.156	44.7
	Air source heat pump	834	0.156	0.0
	Electric heat only	893	0.000	0.0
	Gas heat only	0	0.000	44.7

High-Performance Windows -Small Retail

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,704	0.156	0.0
	AC with gas heat	357	0.156	65.4
	Air source heat pump	1,259	0.156	0.0
	Electric heat only	1,421	0.000	0.0
	Gas heat only	0	0.000	65.4
Binghamton	AC with electric heat	1,797	0.156	0.0
	AC with gas heat	320	0.156	72.2
	Air source heat pump	1,294	0.156	0.0
	Electric heat only	1,559	0.000	0.0
	Gas heat only	0	0.000	72.2
Buffalo	AC with electric heat	1,872	0.156	0.0
	AC with gas heat	327	0.156	75.2
	Air source heat pump	1,309	0.156	0.0
	Electric heat only	1,635	0.000	0.0
	Gas heat only	0	0.000	75.2
Massena	AC with electric heat	1,828	0.156	0.0
	AC with gas heat	329	0.156	71.9
	Air source heat pump	1,433	0.156	0.0
	Electric heat only	1,597	0.000	0.0
	Gas heat only	0	0.000	71.9
NYC	AC with electric heat	1,260	0.156	0.0
	AC with gas heat	437	0.156	40.8
	Air source heat pump	886	0.156	0.0
	Electric heat only	929	0.000	0.0
	Gas heat only	0	0.000	40.8
Poughkeepsie	AC with electric heat	1,085	0.156	0.0
	AC with gas heat	305	0.156	37.4
	Air source heat pump	821	0.156	0.0
	Electric heat only	819	0.000	0.0
	Gas heat only	0	0.000	37.4
Syracuse	AC with electric heat	1,810	0.156	0.0
	AC with gas heat	370	0.156	70.8
	Air source heat pump	1,321	0.156	0.0
	Electric heat only	1,546	0.000	0.0
	Gas heat only	0	0.000	70.8

High-Performance Windows -Warehouse

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with electric heat	1,828	0.156	0.0
	AC with gas heat	326	0.156	70.1
	Air source heat pump	1,478	0.156	0.0
	Electric heat only	1,572	0.000	0.0
	Gas heat only	0	0.000	70.1
Binghamton	AC with electric heat	1,863	0.156	0.0
	AC with gas heat	273	0.156	74.2
	Air source heat pump	1,580	0.156	0.0
	Electric heat only	1,636	0.000	0.0
	Gas heat only	0	0.000	74.2
Buffalo	AC with electric heat	1,977	0.156	0.0
	AC with gas heat	298	0.156	78.9
	Air source heat pump	1,489	0.156	0.0
	Electric heat only	1,714	0.000	0.0
	Gas heat only	0	0.000	78.9
Massena	AC with electric heat	2,382	0.156	0.0
	AC with gas heat	319	0.156	95.9
	Air source heat pump	2,000	0.156	0.0
	Electric heat only	2,130	0.000	0.0
	Gas heat only	0	0.000	95.9
NYC	AC with electric heat	1,243	0.156	0.0
	AC with gas heat	413	0.156	40.0
	Air source heat pump	941	0.156	0.0
	Electric heat only	953	0.000	0.0
	Gas heat only	0	0.000	40.0
Poughkeepsie	AC with electric heat	1,430	0.156	0.0
	AC with gas heat	312	0.156	53.0
	Air source heat pump	1,159	0.156	0.0
	Electric heat only	1,202	0.000	0.0
	Gas heat only	0	0.000	53.0
Syracuse	AC with electric heat	1,748	0.156	0.0
	AC with gas heat	326	0.156	66.9
	Air source heat pump	1,468	0.156	0.0
	Electric heat only	1,507	0.000	0.0
	Gas heat only	0	0.000	66.9

WINDOW FILM

Window Film - Assembly

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	388	0.178	-84.0
Binghamton	AC with gas heat	333	0.178	-93.2
Buffalo	AC with gas heat	358	0.178	-82.0
Massena	AC with gas heat	346	0.178	-100.6
NYC	AC with gas heat	592	0.178	-58.3
Poughkeepsie	AC with gas heat	379	0.178	-92.2
Syracuse	AC with gas heat	426	0.178	-66.0

Window Film - Auto Repair

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	167	0.178	-72.4
Binghamton	AC with gas heat	138	0.178	-63.0
Buffalo	AC with gas heat	159	0.178	-67.7
Massena	AC with gas heat	155	0.178	-74.0
NYC	AC with gas heat	271	0.178	-77.2
Poughkeepsie	AC with gas heat	164	0.178	-84.3
Syracuse	AC with gas heat	169	0.178	-83.5

Window Film - Big Box Retail

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	407	0.178	-54.1
Binghamton	AC with gas heat	357	0.178	-57.5
Buffalo	AC with gas heat	378	0.178	-46.4
Massena	AC with gas heat	370	0.178	-58.5
NYC	AC with gas heat	538	0.178	-38.6
Poughkeepsie	AC with gas heat	402	0.178	-47.9
Syracuse	AC with gas heat	402	0.178	-53.6

Window Film - Fast Food Restaurant

Climate	System	kWh/unit	Summer kW/unit	therm/unit
Albany	AC with gas heat	290	0.178	-82.9
Binghamton	AC with gas heat	241	0.178	-84.5
Buffalo	AC with gas heat	263	0.178	-77.3
Massena	AC with gas heat	268	0.178	-85.2
NYC	AC with gas heat	393	0.178	-72.3
Poughkeepsie	AC with gas heat	282	0.178	-85.0
Syracuse	AC with gas heat	297	0.178	-75.9

Window Film - Full Service Restaurant

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	296	0.178	-109.1
Binghamton	AC with gas heat	249	0.178	-111.0
Buffalo	AC with gas heat	265	0.178	-98.9
Massena	AC with gas heat	273	0.178	-109.4
NYC	AC with gas heat	403	0.178	-94.8
Poughkeepsie	AC with gas heat	297	0.178	-110.2
Syracuse	AC with gas heat	309	0.178	-98.3

Window Film - Grocery

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	407	0.178	-54.1
Binghamton	AC with gas heat	357	0.178	-57.5
Buffalo	AC with gas heat	378	0.178	-46.4
Massena	AC with gas heat	370	0.178	-58.5
NYC	AC with gas heat	538	0.178	-38.6
Poughkeepsie	AC with gas heat	402	0.178	-47.9
Syracuse	AC with gas heat	402	0.178	-53.6

Window Film – Light Industrial

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	232	0.178	-71.6
Binghamton	AC with gas heat	175	0.178	-74.1
Buffalo	AC with gas heat	226	0.178	-62.1
Massena	AC with gas heat	189	0.178	-76.6
NYC	AC with gas heat	251	0.178	-68.4
Poughkeepsie	AC with gas heat	211	0.178	-67.5
Syracuse	AC with gas heat	211	0.178	-65.7

Window Film - Motel

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	445	0.178	-29.0
Binghamton	AC with gas heat	396	0.178	-30.0
Buffalo	AC with gas heat	399	0.178	-27.5
Massena	AC with gas heat	411	0.178	-32.4
NYC	AC with gas heat	523	0.178	-19.8
Poughkeepsie	AC with gas heat	455	0.178	-23.7
Syracuse	AC with gas heat	426	0.178	-27.1

Window Film - Primary School

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	437	0.000	-105.6
Binghamton	AC with gas heat	300	0.000	-108.8
Buffalo	AC with gas heat	382	0.000	-96.8
Massena	AC with gas heat	383	0.000	-108.7
NYC	AC with gas heat	555	0.000	-98.0
Poughkeepsie	AC with gas heat	437	0.000	-107.6
Syracuse	AC with gas heat	415	0.000	-99.9

Window Film - Small Office

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	388	0.178	-84.0
Binghamton	AC with gas heat	333	0.178	-93.2
Buffalo	AC with gas heat	358	0.178	-82.0
Massena	AC with gas heat	346	0.178	-100.6
NYC	AC with gas heat	592	0.178	-58.3
Poughkeepsie	AC with gas heat	379	0.178	-92.2
Syracuse	AC with gas heat	426	0.178	-66.0

Window Film - Small Retail

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	342	0.178	-73.6
Binghamton	AC with gas heat	307	0.178	-73.9
Buffalo	AC with gas heat	307	0.178	-67.7
Massena	AC with gas heat	290	0.178	-83.6
NYC	AC with gas heat	448	0.178	-62.5
Poughkeepsie	AC with gas heat	319	0.178	-70.8
Syracuse	AC with gas heat	347	0.178	-69.6

Window Film - Warehouse

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	516	0.178	-88.3
Binghamton	AC with gas heat	421	0.178	-93.5
Buffalo	AC with gas heat	444	0.178	-80.6
Massena	AC with gas heat	462	0.178	-82.0
NYC	AC with gas heat	613	0.178	-83.8
Poughkeepsie	AC with gas heat	509	0.178	-93.1
Syracuse	AC with gas heat	525	0.178	-86.1

Window Film - Other

Climate	System	ΔkWh/ 100 SF	ΔkW/ 100 SF	Δtherms/ 100 SF
Albany	AC with gas heat	360	0.178	-75.7
Binghamton	AC with gas heat	301	0.178	-78.4
Buffalo	AC with gas heat	326	0.178	-69.6
Massena	AC with gas heat	322	0.178	-80.8
NYC	AC with gas heat	476	0.178	-64.2
Poughkeepsie	AC with gas heat	353	0.178	-76.9
Syracuse	AC with gas heat	363	0.178	-70.4

Record of Revision

Record of Revision Number	Issue Date
0	10/15/2010
9-19-9	9/27/2019

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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[31]
	Clothes Dryer	Residential	14	ENERGY STAR® M&I Scoping Report[32]
	Clothes Washer	Residential	11	DEER 2014 EUL ID: Appl-EffCW
	Dehumidifier	Residential	12	ENERGY STAR® Calc[33]
	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[34]
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[35]
	Air Leakage Sealing	Residential	15	GDS[36]

[31] 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

[32] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.

[33] ENERGY STAR® Dehumidifier Calculator https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

[34] Retail Products Platform Product Analysis, Last Updated May 25, 2016. Available from: https://drive.google.com/file/d/0B9Fd3ckbKJp5OEpWSHg1eksyZ1U/view

[35] At least one manufacturer's warranty period. www.gss-ee.com/products.html

[36] 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[37]
	Insulation – Opaque Shell	Residential	25	GDS[38]
	Storm Window	Residential	20	DOE[39]
	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[40]
	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[41]
	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[42]
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[43]
	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

[37] Ibid.
[38] Ibid.
[39] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22864rev2.pdf
[40] https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[41] 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
[42] 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.
[43] 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[44]
	Boiler and Furnace - Combination ("Combi") Furnace	Residential	20	DEER[45]
	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[46,47]
	Heat Pump - Air Source (ASHP)	Residential	15	DEER 2014 EUL ID: HV-Res HP
	Heat Pump – Ground Source (GSHP)	Residential	25	ASHRAE[48]
	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

[44] 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
[45] Based on DEER value for high efficiency boiler and instantaneous water heater
[46] 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
[47] 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
[48] 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[49]
	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[50]

[49] NYSERDA Residential Electric Submetering Manual
[50] 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[51]
	LED Lamp (Directional)	Residential/ Multifamily Common Area	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Lamps[52]
			35,000 or 50,000 hours	DLC[53]
	LED Lamp (Decorative & Omnidirectional)	Residential/ Multifamily Common Area	15,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR® Lamps

[51] 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

[52] 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

[53] 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[54]
		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[55] 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[56]
Lighting Control	Bi-Level Lighting		Multifamily Common Area	15	ComEd[57]
Motors and Drives	Pool Pump		Residential	10	DEER 2014 EUL ID: OutD-PoolPump
Other	Pool Heater		Residential	8	DOE[58]

[54] 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
[55] Basis value 70,000 hours, capped at 20 years, is common given redecoration patterns
[56] Basis value 22,000 hour ballast life per US EPA. Capped at 20 years as above (2.5 hours per day average lamp operation)
[57] 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
[58] 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[59]
Appliance	Clothes Dryer	C&I	14	ENERGY STAR®M&I Report[60]
	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[61]
	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[62]
	Insulation - Opaque Shell	C&I	30	ET & CEC[63]
	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[64]
	Engineered Air Nozzle	C&I	15	Wisconsin PSC[65]

[59] Based on EUL's for similar control technology
[60] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[61] 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
[62] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures
[63] Energy Trust uses 30 years for commercial applications. CEC uses 30 years for insulation in Title 24 analysis.
[64] 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.
[65] 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[66]
	Refrigerated Air Dryer	C&I	13	Other State TRMs [67]
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[68]
	Boiler and Furnace - Combination (“Combi”) Furnace	C&I	20	DEER[69]
	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

[66] 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

[67] 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.

[68] 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

[69] 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[70]
	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[71],[72]
	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[73]
	Infrared Heater	C&I	17	GDS[74]
	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[75]
	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

[70] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003)
[71] 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
[72] 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
[73] ASHRAE Owning and Operating Cost Database
Available from: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1
[74] 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
[75] 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[76]
Lighting	CFL Lamp	C&I	9,000 hours /annual lighting operating hours	See note below[77]
	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[78] EUL ID: ILtg-Lfluor-Elec

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

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

[78] 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[79]
			35,000 hours /annual lighting operating hours or 20 years (whichever is less)	ENERGY STAR®[80]
			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[81]
	Integrated Interior Lighting Control	C&I	15	ComEd[82]
	Non-Integrated Interior Lighting Control	C&I	10	GDS[83]
	Plug-Load Occupancy Sensor	C&I	8	DEER[84]

[79] 50,000 hours per L_{70} requirements prescribed by the DLC's Product Qualification Criteria, Technical Requirement Table version 4.2

[80] 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

[81] 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

[82] 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

[83] 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

[84] 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
	Elevator Modernization	C&I	15	DEER 2014 *Assumes same EUL as VFD measure*
Other	Pool Heater	C&I	8	DOE[85]
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

[85] 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	9/27/2017
12-17-17	12/31/2017
3-18-21	3/31/2018
6-18-23	6/30/2018
9-18-21	9/27/2018
12-18-17	12/28/2018
3-19-16	3/29/2019
6-19-14	6/30/2019
9-19-10	9/27/2019

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