Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
1-17-1	R	12/31/2016	1/1/2017	R/MF – Clothes Washer	Revised savings formulas and default values and expanded baseline and prescribed savings value tables	Pg. 5
1-17-2	R	12/31/2016	1/1/2017	R/MF – Advanced Power Strips	Added provisions for Tier 2 APS savings estimation and modified approach for Tier 1 APS savings	Pg. 18
1-17-3	R	12/31/2016	1/1/2017	R/MF – Programmable Thermostats	Revised savings factors and clarified correct application of variables	Pg. 119
1-17-4	R	12/31/2016	1/1/2017	R/MF – Lighting	Removed alternative approach for savings estimation; added in-service rate factor to calculation methodology; added operating hours assumption for exterior lighting and baseline wattage tables	Pg. 130
1-17-5	R	12/31/2016	1/1/2017	C/I – Unitary AC	Added Unitary & Applied Heat Pumps to measure designation and modified savings formulas to be inclusive; revised baseline efficiency tables	Pg. 190
1-17-6	R	12/31/2016	1/1/2017	C/I – Packaged Terminal Heat Pump	Added Package Terminal AC to measure designation and modified savings formulas to be inclusive; revised baseline efficiency tables	Pg. 209
1-17-7	R	12/31/2016	1/1/2017	C/I – Lighting	Added in-service rate factor to calculation methodology and revised savings estimation approach	Pg. 217
1-17-8	R	12/31/2016	1/1/2017	Appendix P	Updated EUL entries for all measures contained in this Record of Revision	Pg. 530
1-17-9	R	12/31/2016	1/1/2017	Glossary	Added entries for CEE, ElecSF and GasSF	Pg. 539

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between July 1, 2016 – December 31, 2016.

RESIDENTIAL - APPLIANCE

CLOTHES WASHER

Measure Description

A residential clothes washer is a consumer product designed to clean clothes, utilizing a water solution of soap and/or detergent and mechanical agitation or other movement, and must be one of the following classes: automatic clothes washers, semi-automatic clothes washers, and other clothes washers. This measure addresses installation of top and front-loading residential clothes washers with capacities greater than 1.6 ft^3 and less than 6.0 ft^3 meeting the minimum qualifying efficiency standards established under the ENERGY STAR® Program, effective March 7, 2015[1]. The washers are assumed to be located within the residential unit, not a commercial washer in a common area laundry room. There is natural gas energy savings associated with the thorough water removal from the clothes in the washer.

Method for Calculating Annual Energy and Peak Coincident Demand Savings[2]

Annual Electric Energy Savings

$$\Delta kWh = units \times ((\Delta kWh_{washer} + \Delta kWh_{wh} \times ElecSF_{wh}) + (\Delta kWh_{dryer} \times ElecSF_{dryer}))$$

Peak Coincident Demand Savings

$$\Delta kW = units \times \left(\frac{\Delta kWh}{Hours}\right) \times CF$$

Annual Gas Energy Savings

$$\Delta therms = units \times ((\Delta therm_{wh} \times GasSF_{wh}) + (\Delta therm_{dryer} \times GasSF_{dryer}))$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
$\Delta therms$	= Annual gas energy savings
units	= Number of measures installed under the program
ΔkWh_{washer}	= Annual clothes washer electric energy savings (in kWh) associated with

[1] ENERGY STAR® Program Requirements Product Specification for Clothes Washers, Eligibility Criteria Version 7.1 (as of March 7, 2015) https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%207.1%20Clothes%20Washers%20Program%20Requirements_1.pdf

2 Electric and Gas Energy Savings algorithms and per unit savings values derived from ENERGY STAR® Savings Calculator for ENERGY STAR® Qualified Appliances (as of October 1, 2016) https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx

qualified clothes washer installation

ΔkWh_{wh} = Annual electric water heating energy savings (in kWh) associated with qualified clothes washer installation

ΔkWh_{dryer} = Annual electric dryer energy savings (in kWh) associated with qualified clothes washer installation

$ElecSF_{wh}$ = Electric Savings Factor for water heaters: Adjustment to electric water heating energy savings based on water heating fuel

$ElecSF_{dryer}$ = Electric Savings Factor for dryers: Adjustment to electric dryer energy savings based on dryer type

$\Delta therm_{wh}$ = Annual gas water heating energy savings (in therms) associated with qualified clothes washer installation

$\Delta therm_{dryer}$ = Annual gas dryer energy savings (in therms) associated with qualified clothes washer installation

$GasSF_{wh}$ = Gas Savings Factor for water heaters: Adjustment to gas water heating energy savings based on water heating fuel

$GasSF_{dryer}$ = Gas Savings Factor for dryers: Adjustment to gas dryer energy savings based on dryer type

Hours = Clothes Washer Annual Operating Hours

CF = Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
ΔkWh_{washer}		From Per Unit Savings table below, based on product class
ΔkWh_{wh}		From Per Unit Savings table below, based on product class
ΔkWh_{dryer}		From Per Unit Savings table below, based on product class
$ElecSF_{wh}$	Electric WH: 100% Gas WH: 0% Unknown: 65%	Based on EIA Residential Energy Consumption Survey (RECS) 2009 for Mid Atlantic States.
$ElecSF_{dryer}$	Electric Dryer: 100% Gas Dryer: 0% Unknown: 79%	Based on EIA Residential Energy Consumption Survey (RECS) 2009 for Mid Atlantic States.
$\Delta therms_{wh}$		From Per Unit Savings table below, based on product class
$\Delta therms_{dryer}$		From Per Unit Savings table below, based on product class
$GasSF_{wh}$	Electric WH: 0% Gas WH: 100% Unknown: 35%	Based on EIA Residential Energy Consumption Survey (RECS) 2009 for Mid Atlantic States.
$GasSF_{dryer}$	Electric Dryer: 0% Gas Dryer: 100% Unknown: 6%	Based on EIA Residential Energy Consumption Survey (RECS) 2009 for Mid Atlantic States.
Hours	295	
CF	0.029	

Per Unit Savings[3]

Product Class	Clothes Washer Savings (ΔkWh_{washer})	Electric DHW Savings (ΔkWh_{wh})	Gas DHW Savings ($\Delta therm_{wh}$)	Electric Dryer Savings (ΔkWh_{dryer})	Gas Dryer Savings ($\Delta therm_{dryer}$)
ENERGY STAR Front Load Washer ≤ 2.5 ft^3	4	15	0.7	19	0.7
ENERGY STAR Front Load Washer > 2.5 ft^3	6	25	1.2	119	4.5
ENERGY STAR Top Load Washer ≤ 2.5 ft^3	8	33	1.5	146	5.6
ENERGY STAR Top Load Washer > 2.5 ft^3	23	91	4.1	283	10.8
ENERGY STAR Most Efficient Front Load Washer > 2.5 ft^3	6	25	1.2	190	7.3
ENERGY STAR Most Efficient Top Load Washer > 2.5 ft^3	23	91	4.1	454	17.3
CEE Tier 1 Front Load Washer ≤ 2.5 ft^3	4	15	0.7	60	2.3
CEE Tier 1 Front Load Washer > 2.5 ft^3	6	25	1.2	119	4.5
CEE Tier 1 Top Load Washer ≤ 2.5 ft^3	8	33	1.5	186	7.1
CEE Tier 1 Top Load Washer > 2.5 ft^3	23	91	4.1	373	14.3
CEE Tier 2 Front Load Washer ≤ 2.5 ft^3	4	15	0.7	96	3.7
CEE Tier 2 Front Load Washer > 2.5 ft^3	6	25	1.2	187	7.1
CEE Tier 2 Top Load Washer ≤ 2.5 ft^3	8	33	1.5	222	8.5
CEE Tier 2 Top Load Washer > 2.5 ft^3	23	91	4.1	450	17.2
CEE Tier 3 Front Load Washer ≤ 2.5 ft^3	4	15	0.7	110	4.2
CEE Tier 3 Front Load Washer > 2.5 ft^3	6	25	1.2	215	8.2
CEE Tier 3 Top Load Washer ≤ 2.5 ft^3	8	33	1.5	237	9.0
CEE Tier 3 Top Load Washer > 2.5 ft^3	23	91	4.1	481	18.4

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.029[4]

Baseline Efficiencies from which Savings are Calculated

Clothes washers manufactured and distributed in commerce, as defined by 42 U.S.C. 6291(16), on or after March 7, 2015, and before January 1, 2018, must meet the energy conservation standards shown in the table below, as specified in the Code of Federal Regulations, 10 CFR 430.32(g)(3). This information is also available in the Electronic Code of Federal Regulations.

Product Class	IMEF	IWF
Top-loading, Compact (< 1.6 ft^3)	≥ 0.86	≤ 14.4
Top-loading, Standard (≥ 1.6 ft^3)	≥ 1.29	≤ 8.4
Front-loading, Compact (< 1.6 ft^3)	≥ 1.13	≤ 8.3
Front-loading, Standard (≥ 1.6 ft^3)	≥ 1.84	≤ 4.7

Integrated Modified Energy Factor, IMEF[5] (ft^3/kWh /cycle), is the energy performance metric for ENERGY STAR® certified *residential clothes washers as of March 7, 2015*.

[3] ENERGY STAR® Savings Calculator for ENERGY STAR® Qualified Appliances
[4] Metered data from Navigant Consulting "EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Appliance Rebate Program." March 21, 2014, page 36.
[5] 10 CFR 430, Subpart B, Appendix J2

IMEF is the quotient of the capacity of the clothes container, C, divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, M, the hot water energy consumption, E, the energy required for removal of the remaining moisture in the wash load, D and the combined low-power mode energy consumption, L. The higher the value, the more efficient the clothes washer is.[6]

Integrated Water Factor, IWF[7] is the water performance metric for *residential clothes washers* that allows the comparison of clothes washer water consumption independent of clothes washer capacity. Manufacturers must submit their water consumption factors with their ENERGY STAR® certified residential clothes washers. IWF is the quotient of the total weighted per-cycle water consumption for all wash cycles, QA, divided by the capacity of the clothes washer, C. The lower the value, the more water efficient the clothes washer is[8].

Compliance Efficiency from which Incentives are Calculated

For ENERGY STAR® qualified clothes washer eligibility, only front and top-loading clothes washers with capacities greater than 1.6 ft^3 and less than 6.0 ft^3; and are not defined as Combination All-In One Washer-Dryers or Residential Clothes Washers with an Optional Dry Cycle are eligible for ENERGY STAR® Certification[9]. Additional qualifying product criteria are provided in the table below in order to capture anticipated savings associated with higher efficiency models. The highest efficiency "Product Class" that the qualifying unit is eligible for should be used to establish savings from the Per Unit Savings table above.

ENERGY STAR® and Consortium for Energy Efficiency (CEE) Product Criteria Levels are shown in table below:

Product Class	IMEF	IWF
ENERGY STAR Clothes Washer ≤ 2.5 ft^3	≥ 2.07	≤ 4.2
ENERGY STAR Front Load Washer > 2.5 ft^3	≥ 2.38	≤ 3.7
ENERGY STAR Top Load Washer > 2.5 ft^3	≥ 2.06	≤ 4.3
ENERGY STAR Most Efficient Washer > 2.5 ft^3	≥ 2.76	≤ 3.2
CEE Tier 1 Clothes Washer	≥ 2.38	≤ 3.7
CEE Tier 2 Clothes Washer	≥ 2.74	≤ 3.2
CEE Tier 3 Clothes Washer	≥ 2.92	≤ 3.2

[6] ENERGY STAR® Program Requirements Product Specification for Clothes Washers, Eligibility Criteria Version 7.1 (as of March 7, 2015)
[7] 10 CFR 430, Subpart B, Appendix J2
[8] ENERGY STAR® Program Requirements Product Specification for Clothes Washers, Eligibility Criteria Version 7.1 (as of March 7, 2015)
[9] ENERGY STAR® Program Requirements Product Specification for Clothes Washers, Eligibility Criteria Version 7.1 (as of March 7, 2015)

Operating Hours
An average of 295 annual one-hour active wash cycles is assumed in order to estimate conventional and qualifying unit consumption and demand savings.[10]

Effective Useful Life (EUL), single-family residential
Years: 11
Source: DEER 2014[11]

Effective Useful Life (EUL), multi-family residential
Years: 14
Source: DOE 2014[12]

Ancillary Fossil Fuel Savings Impacts
Anticipate further review of ancillary fossil fuel impacts.

Ancillary Electric Savings Impacts
Anticipate further review of ancillary electric savings impacts.

References

1. Multi-family residential unit lifetime defined by U.S. DOE 2014-12-15 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Clothes Washers. (Final Rule); Appendix 8-C. Lifetime Distributions Table 8-C.1.1
   http://www.regulations.gov/document?D=EERE-2012-BT-STD-0020-0036

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
2	6/30/2016
1-17-1	12/31/2016

Return to Table of Contents

[10] DOE Federal Register, 77 FR 45 (Mar. 7, 2012 as corrected Apr. 6 2012)
http://www.regulations.gov/contentStreamer?documentId=EERE-2010-BT-TP-0021-0037&disposition=attachment&contentType=pdf
[11] California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014; Updated-EULrecords_02-07-2014; EUL ID: Appl-EffCW
Available at: http://deeresources.com/files/deerchangelog/deerchangelog.html
[12] U.S. DOE 2014-12-15 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Clothes Washers. (Final Rule); Appendix 8-C. Lifetime Distributions Table 8-C.1.1
http://www.regulations.gov/document?D=EERE-2012-BT-STD-0020-0036

ADVANCED POWER STRIPS (APS)

Tier 1 Measure Description
Tier 1 Advanced Power Strips (APS) are designed to reduce standby energy waste resultant from use of a standard power strip. A Tier 1 APS contains a control outlet that monitors the power state of a master device (typically a TV or desktop computer) and cuts power to all of the power strip's outlets when the master device is off. This reduces the energy and power consumption of a collection of interconnected equipment (i.e. entertainment centers and home offices) by eliminating standby loads. The Tier 1 measure provides savings for both home office and entertainment system equipment. This measure applies to power strips with 5 outlets or more.

Tier 2 Measure Description
Tier 2 Advanced Power Strips (APS) are designed to reduce energy waste by turning off Audio & Video (A/V) equipment while in idle mode. Active power waste occurs when electronic equipment is on, but the equipment is not being used. Standby power loss occurs when energy is consumed by equipment while it is turned off and in idle mode, but is still plugged in. Tier 2 APS realize savings by reducing both active and standby power loss, which can give significant energy savings over a Tier 1 Advanced Power Strip. This measure is designed to estimate electric savings for installing Tier 2 Advanced Power Strips for entertainment systems only. There is no incremental savings from home office equipment. This measure applies to power strips with 5 outlets or more. Existing systems include standard power strips or Tier 1 Advanced Power Strips.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units * ESF$$

Peak Coincident Demand Savings

$$\Delta kW = \frac{\Delta kWh}{hours} * CF$$

Annual Gas Energy Savings

$$\Delta Therms = N/A$$

where:

ΔkWh	= Annual kWh savings from installing a Tier 1 or Tier 2 APS
ΔkW	= Demand savings from installation a Tier 1 or Tier 2 APS
units	= Installation of a Tier 1 or Tier 2 Advanced Power Strip
ESF	= Energy Savings Factor (kWh/Unit) per table below
Hours	= Annual run hours that the connected system is on standby or is turned off

CF = Coincidence Factor

Summary of Variables & Data Sources

Variable	Value	Notes/References
ESF	Tier 1 – AV Equipment: 75.1 kWh	**Tier 1 APS**: Reference 1 **Tier 2 APS**: Reference 2 Tier 2 savings over Tier 1 baseline established as full Tier 2 savings (322.2 kWh) minus Tier 1 AV Equipment Savings (75.1 kWh) = 247.1 kWh
	Tier 1 – IT Equipment: 31 kWh	
	Tier 1 – Unknown Equipment: 31 kWh	
	Tier 2 – AV Equipment; Standard Power Strip Baseline: 322.2 kWh	
	Tier 2 – AV Equipment; Tier 1 Power Strip Baseline: 247.1 kWh	
	Tier 2 – AV Equipment; Unknown Baseline: 247.1 kWh	
Hours	8,048	See Operating Hours Section Below
CF	0.8	Reference 3

Coincidence Factor (CF)
The recommended value for the coincidence factor is 0.8.

Baseline System from which Savings are Calculated
The baseline system is either a standard power strip or a Tier 1 Advanced Power Strip (Tier 2 only).

Compliance Efficiency from which Incentives are Calculated
Savings are based on plug load control via Tier 1 or Tier 2 Advanced Power Strips.

Operating Hours
Advanced Power Strips are assumed to be plugged in at all times. Annual hours when the equipment is turned off are 7,340. The equipment is estimated to be in standby mode 1.94 hours/day or 708 hours/year. Savings are achieved during periods when equipment is off or in standby mode. Thus, the hours of operation used to determine demand savings are 7,340 + 708 = 8,048. No savings are achieved during the remaining 712 hours per year when equipment is in use.[1]

[1] Derived from CalPlug Tier 2 APS Evaluation Study
Retrieved from: http://embertec.com/assets/pdf/CalPlug_Tier2_APS_Evaluation.pdf

Effective Useful Life (EUL)
Years: 8
Source: DEER 2014[2]

Ancillary Fossil Fuel Savings Impacts
N/A

Ancillary Electric Savings Impacts
N/A

References

1. New York State Energy Research and Development Authority, "Advanced Power Strip Research Report." August 2011. Study available at https://www.nyserda.ny.gov/Residents-and-Homeowners/Your-Home/Power-Management
2. California Plug Load Research Center (May 7, 2014). Tier 2 Advanced Power Strip Evaluation for Energy Saving Incentive. Retrieved from http://embertec.com/assets/pdf/CalPlug_Tier2_APS_Evaluation.pdf
3. Northeast Energy Efficiency Partnerships. "Mid-Atlantic Technical Reference Manual Version 6." May 2016. http://www.neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V6_FINAL_R1_CLEAN.DOCX
4. San Diego Gas & Electric. "Tier 2 Advanced Power Strip." January 2015. https://static1.squarespace.com/static/53c96e16e4b003bdba4f4fee/t/54bd8489e4b0f0fba7fc835e/1421706377932/WPSDGEREHE0004+Tier+2+Advanced+Power+Strips+-+FINAL.pdf

Record of Revision

Record of Revision Number	Issue Date
1	12/31/2015
1-17-2	12/31/2016

Return to Table of Contents

[2] California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-07-2014; EUL ID: Plug-OccSens
Available at: http://deeresources.com/files/deerchangelog/deerchangelog.html

HEATING, VENTILATION AND AIR CONDITIONING (HVAC) – CONTROL

THERMOSTAT – PROGRAMMABLE SETBACK

Measure Description
Programmable setback thermostats applied to single-family and multi-family residential air conditioners, heat pumps, boilers, furnaces and electric resistance baseboard heating systems.

One programmable thermostat may be applied to each controlled HVAC system.

Method for Calculating Annual Energy and Peak Coincident Demand Savings
Annual Electric Energy Savings

$$\Delta kWh = units \times \left[\begin{array}{l} \left(tons/unit \times \left(\frac{12}{SEER} \right) \times EFLH_{cooling} \times F_{cooling} \right) \\ + \left(kBTUh_{out}/unit \times \left(\frac{1}{HSPF} \right) \times EFLH_{heating} \times F_{heating} \right) \end{array} \right]$$

Peak Coincident Demand Savings

ΔkW = N/A

Annual Gas Energy Savings

$$\Delta therms = units \times \left[kBTUh_{in}/unit \times \left(\frac{1}{100} \right) \times EFLH_{heating} \times F_{heating} \right]$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
$\Delta therms$ = Annual gas energy savings
units = Number of residences in which measure is installed under the program
tons/unit = Tons of air conditioning per residence, based on nameplate data; for multifamily with central HVAC, this includes all residences served by central HVAC system
$kBTUh_{out}$/unit = Output electric heating capacity in kBTU/h per residence, based on nameplate data (heat pumps); for multifamily with central HVAC, this includes all residences served by central HVAC system
$kBTUh_{in}$/unit = Input heating capacity in kBTU/h per residence, based on nameplate data (boilers, furnaces and electric resistance heating); for multifamily with central HVAC, this includes all residences served by central HVAC system
SEER = Seasonal energy efficiency ratio in Btu/watt-hour. Total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/h, divided by the total electric energy input during the same period, in watt-hours.

HSPF = Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric strip heat) during the heating season / total electric energy heat pump consumed (in watt/hr)
$EFLH_{cooling}$ = Cooling equivalent full-load hours
$EFLH_{heating}$ = Heating equivalent full-load hours
$F_{heating}$ = Energy savings factor for heating (percent of total consumption saved)
$F_{cooling}$ = Energy savings factor for cooling (percent of total consumption saved)
12 = kBTUh/ton of air conditioning capacity
100 = Conversion factor, kBTUh/therm

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application or use 3 as default. Use 0 if no central cooling
SEER	10	
$EFLH_{cooling}$		Vintage weighted average by city.
$F_{cooling}$	0.131	Energy savings factor for cooling
$EFLH_{heating}$		Vintage weighted average by city.
$F_{heating}$	0.05	Energy savings factor for heating
If heat pump:		
$kBTUh_{out}$/unit		From application or use 70 kBTU/hr as default
HSPF	6.8	Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric strip heat) during the heating season / total electric energy heat pump consumed (in watt/hr)
If furnace:		
$kBTUh_{in}$/unit		From application or use 90 kBTU/hr as a default. Use weighted average of furnace and boiler if system type unknown.
If boiler:		
$kBTUh_{in}$/unit		From application or use 110 kBTU/hr as default. Use weighted average of furnace and boiler if system type is unknown.
If resistance heater:		
$kBTUh_{in}$/unit		From application or use 12 kBTU/hr (3.5 kW) as default
HSPF	3.412	Equivalent to COP = 1

The nominal rating of the cooling capacity of the air conditioner or heat pump should be set equal to the rated capacity of all cooling equipment in the residence. The energy savings should be calculated per residence rather than per thermostat. For multifamily with central HVAC, total cooling capacity of the system should be used.

The nominal rating of the heating capacity of the heat pump should be set equal to the rated capacity of all heating equipment controlled in the residence. The energy savings should be

calculated per residence rather than per thermostat. For multifamily with central HVAC, total heating capacity of the system should be used.

Coincidence Factor (CF)
The recommended value for the coincidence factor is: N/A

Baseline Efficiencies from which Savings are Calculated
The baseline efficiency for air conditioners and heat pumps should be set according to the sections on air conditioner and heat pump efficiency above. Electric resistance heating systems should use an HSPF = 3.412, which is equivalent to a coefficient of performance of 1.0.

Studies of residential heating thermostat set point behavior indicate some amount of manual setback adjustment in homes without programmable thermostats. This behavior is accounted for in the prototypical building simulation model used to calculate heating equivalent full-load hours, as described in Appendix A. An assumption of 3°F of night time setback behavior is embedded in the models.

Compliance Efficiency from which Incentives are Calculated
The energy savings factor for heating ($F_{heating}$) is the ratio of the energy savings resulting from installation of a programmable setback thermostat to the annual heating energy. The heating energy savings factor assumption is taken from a study of programmable thermostat savings in Indiana conducted by the Cadmus Group in 2013 - 2014. The study estimated an energy savings of 5.0% of the annual heating energy consumption for programmable setback thermostats in residential applications.

The cooling energy savings factor ($F_{cooling}$) is the ratio of the energy savings resulting from installation of a programmable setback thermostat to the annual cooling energy. The recommended value for the cooling energy savings factor is 13.1%. This recommendation is taken from the 2013 – 2014 Indiana study conducted by Cadmus.

Operating Hours
Cooling and heating equivalent full-load hours calculated from building energy simulation models are described in Appendix A and summarized in Appendix G.

Effective Useful Life (EUL)
Years: 11
Source: DEER[1]

Ancillary Fossil Fuel Savings Impacts
N/A

Ancillary Electric Savings Impacts
N/A

[1] California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014; Updated-EULrecords_02-07-2014; EUL ID: HVAC-ProgTStats
Available at: http://deeresources.com/files/deerchangelog/deerchangelog.html

References

1. For examples of studies on residential thermostat set point behavior, see the literature review conducted for the California Energy Commission project "Residential Thermostats: Comfort Controls in California Homes," CEC-500-03-026, available at http://eetd.lbl.gov/sites/all/files/lbnl-938e_3.pdf
2. Baseline thermostat setback assumptions taken from: Conner, C.C. and Lucas, R.L. 1990. Thermostat Related Behavior and Internal Temperatures Based on Measured Data in Residences. PNL-7465, Pacific Northwest Laboratory. Richland, WA. http://elcap.nwcouncil.org/Documents/Thermostat%20Related%20Behavior.PDF
3. The Cadmus study on thermostat savings can be found at: http://www.cadmusgroup.com/papers-reports/evaluation-2013-2014-programmable-smart-thermostat-program/

Record of Revision

Record of Revision Number	Issue Date
0	10/15/2010
1	12/31/2015
1-17-3	12/31/2016

Return to Table of Contents

LIGHTING

LIGHT EMITTING DIODE (LED), COMPACT FLUORESCENT LAMP (CFL) AND OTHER LIGHTING

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

Beginning, January 2014, the Energy Independence and Security Act of 2007 (EISA) regulations stipulated typical 60W and 40W lamp wattages to comply with 43W and 29W lamp wattage standards for rated lumen output ranges of 750-1049 and 310-749 lumens, respectively. Deemed baseline values for this measure will apply wattages based on lamp type and light output (lumens).[1]

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times (1 - leakage) \times (W_{baseline} - W_{ee})/1{,}000 \times ISR \times hrs_{operating} \times (1 + HVAC_c)$$

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = units \times (1 - leakage) \times (W_{baseline} - W_{ee})/1{,}000 \times ISR \times hrs_{operating} \times HVAC_g$$

where:

ΔkWh	= Annual Electric Energy Savings
ΔkW	= Peak Coincident Demand Savings
Δtherms	= Annual Gas Energy Savings
units	= Number of Measures Installed
leakage	= Percentage of Units Not Installed in Service Territory, Estimated Percentage
W	= Watts, Rated Wattage of Lamp and/or Fixture
baseline	= Baseline Condition
ee	= Energy Efficient Measure

[1] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 86 https://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf

1,000 = Conversion factor, one kW equals 1,000 watts
ISR = In Service Rate, percentage of units rebated that are actually in service.
CF = Coincidence Factor, Average Summer Value
$hrs_{operating}$ = Operating Hours
$HVAC_c$ = HVAC Interaction Factor for annual electric energy consumption
$HVAC_d$ = HVAC Interaction Factor at utility summer peak hour
$HVAC_g$ = HVAC Interaction Factor for annual natural gas consumption

Summary of Variables and Data Sources

Variable	Value	Notes
units	From application	Equal to number of lamps sold/distributed under the program.
W_{ee}	From application	Energy Efficient measure watts
$W_{baseline}$	From application or default values from applicable table in "Baseline Efficiencies…" section below	Baseline measure watts
$hrs_{operating}$	1,168 (interior lamps) 913 (interior fixtures) 1,643 all exterior	Lighting operating hours
leakage	Based on program, use 0 if unknown.	Determined through evaluation for upstream lighting programs and EE kits. All other programs use 0.
ISR	LED: 100% Other: 92%	In Service Rate, percentage of rebate units that get installed immediately.
Coincidence factor (CF)	0.08 – Interior 0 - Exterior	Use average summer value. "Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.
$HVAC_c$	See Appendix D 0 for Exterior	HVAC interaction factor for annual electric energy consumption. Vintage and HVAC type weighted average by city.
$HVAC_d$	See Appendix D 0 for Exterior	HVAC interaction factor at utility summer peak hour. Vintage and HVAC type weighted average by city.
$HVAC_g$	See Appendix D 0 for Exterior	HVAC interaction factor for annual natural gas consumption. Vintage and HVAC type weighted average by city

Operating Hours

Lamps

Hours of operation for lamps are estimated to be 3.2 operating hours per day or 1168 (3.2 x 365) hours per year. The 3.2 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island, and Vermont[2]. The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day, based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 4.8 hours from the markdown program component and 3.2 from the coupon program component.[3] This value represents a trade-off among factors that may affect the extent to which any out-of New York State value is applicable to NY. These include such factors as differences between the study area and NY, related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 3.2 appears to be the most reasonable prior to New York-specific impact studies. This value is appropriate for interior applications only. For exterior applications, assume a total of 1,643 hours which is based on updated results from the 2003 Nexus Market Research[4].

Fixtures

Hours of operation for fixtures are estimated to be 2.5 operating hours per day or 913 (2.5 x 365) hours per year. The 2.5 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island and Vermont[2]. The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day, based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 2.4 for interior fixtures[3]. The proposed value represents a trade-off among factors that may affect the extent to which any value from outside of New York State is applicable to NY. These include such factors as differences between the study area and NY related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 2.5 appears to be the most reasonable prior to New York specific impact studies.

Leakage

This defined term is used to describe units that may not ultimately be placed in to service within the utility territory. Leakage occurs primarily in retail and educational (upstream) programs, where the Program Administrator does not have control over either who purchases

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

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

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

the lamps or where they are ultimately installed, therefore reducing the anticipated savings. The values are used to estimate savings per lamp, and must be multiplied by the number of lamps installed and operating. For some programs, such as upstream programs, an adjustment to the unit count must be made for lamps that may have been sold to customers living outside New York State or the utility's service territory.

In Service Rate

This term is used to describe the percentage of rebated bulbs that are not installed or removed upon installation. ISR values will vary based on technology and program type. Until results of program evaluations on specific program delivery methods administered throughout New York State refine this approach, a value of 92% is assumed for fluorescent lighting, based on a discounted 3-year ISR utilizing a 7.5% discount rate and methodology/assumed values per the NREL Uniform Methods Project. Due to comparatively high cost of LEDs, it is likely that the ISR for this tech will be close to 100%. These values should be amended pending further research and program evaluations.

Coincidence Factor (CF)

The coincidence factors were derived from an examination of studies throughout New England that calculated coincident factors based on the definition of system peak period at the time, as specified by the New England Power Pool and later, ISO-New England.

Lighting Summer On-Peak Hours (1PM-5PM)	Coincidence Factor
June	0.07
July	0.09
August	0.09
Average Summer	0.08

Baseline Efficiencies from which Savings are Calculated

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

General Service Lamps[5]

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

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

Certain lamp types are exempt from EISA compliance, including reflector lamps (see Reflector/Flood Lamps section below), decorative and globe shape lamps (see Specialty Lamps section below) and three-way lamps. Baseline wattage for any of these exempt lamp types should reflect the values in column (c) of the table below, with the exception of those lamps defined in the Specialty Lamps or Reflector/Flood Lamps sections below. All other general service lamps should use the baseline wattage values in column (b), corresponding to the applicable lumen range identified in column (a). For standard lamps that fall outside of the prescribed lumen ranges below, the manufacturer recommended baseline wattage should be used. For a complete list and definitions of EISA-exempt lamp types, reference Sec. 321: Efficient Light Bulbs of Public Law 110-140.
(https://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf).

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

[5] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 82-86

Specialty Lamps[6]

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

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

Reflector/Flood Lamps[7]

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

Bulb Type **(a)**	**Lumen Range** **(b)**	**$W_{baseline}$** **(c)**
ER30, BR30, BR40, or ER40	200 – 299	30
	300 – 449	40
	450 – 499	45
	500 – 1,419	65
R20	200 – 299	30
	300 – 449	40
	400 – 449	40
	450 – 719	45
All other R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.25", other than those listed above	200 – 299	30
	300 – 599	40
	600 – 849	50
	850 – 999	55
	1000 – 1,300	65

[6] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 21: Residential Lighting Evaluation Protocol, National Renewable Energy Laboratory, December 2014, p. 8-11
http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf

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

Effective Useful Life (EUL)
See Appendix P.

Ancillary Fossil Fuel Savings Impacts
Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts addressed in prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts
Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts addressed in prescribed energy savings calculation methodology.

References

1. This method is based on the documentation provided in the CL&P and UI Program Savings Documentation for 2008 Program Year.
2. Other similar reports under review include the Efficiency Vermont and Efficiency Maine Technical Reference User Manuals.
3. Impact evaluations of residential lighting programs in several New England states reviewed in preparing the proposed hours-of-use values and coincidence factors include:
   a. Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs, prepared for Cape Light Compact, Vermont Public Service Department, National Grid Massachusetts and Rhode Island, Western Massachusetts Electric Company, NSTAR Electric, Fitchburg G&E by Nexus Market Research Inc., and RLW Analytics Inc., Oct 1, 200;
4. "Extended residential logging results" memo to Angela Li, National Grid, by Tom Ledyard, RLW Analytics Inc., and Lynn Hoefgen, Nexus Market Research Inc., May 2, 2005;
5. Market Progress and Evaluation Report for the 2005 Massachusetts ENERGY STAR Lighting Program, prepared for Cape Light Compact, National Grid – Massachusetts, NSTAR, Western Massachusetts Electric Company by Nexus Market Research Inc, RLW Analytics, Inc., Shel Feldman Management Company, Dorothy Conant. September 29, 2006;
6. Process and Impact Evaluation of the Efficiency Maine Lighting Program, prepared for Efficiency Maine by Nexus Market Research Inc. and RLW Analytics Inc., April 10, 2007;
7. Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures - For use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM), prepared for the New England State Program Working Group by RLW Analytics Inc., Spring 2007

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
7-13-2	7/31/2013
6-15-3	6/1/2015

1-16-3	12/31/2015
1-17-4	12/31/2016

Return to Table of Contents

Unitary Air Conditioner and Unitary & Applied Heat Pump

Measure Description

Unitary Air Conditioner

One or more factory-made assemblies, which normally include a cooling coil, an air moving device, a compressor(s) and condenser combination, and may include a heating function as well. The functions of commercial and industrial Unitary Air Conditioners, either alone or in combination with a heating plant, are to provide air circulation, cooling, dehumidification, and may include the functions of heating, humidifying, outdoor air ventilation, and air cleaning.[1]

Unitary and Applied Heat Pump

One or more factory-made assemblies, which normally include an indoor conditioning coil, an air moving device, compressor(s), and an outdoor coil(s), including means to provide a heating function and may or may not include a cooling function. Such equipment may be provided in one assembly by a single manufacturer (unitary) or separate assemblies designed to be used together (applied). Commercial and industrial Unitary Heat Pumps shall provide the function of heating and may include the function of air circulation, air cooling, dehumidifying or humidifying, outdoor air ventilation, and air cleaning.[2]

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

$$\Delta kWh = units \times \left[\begin{array}{l} \left(tons/unit \times \left(\frac{12}{SEER_{baseline}} - \frac{12}{SEER_{ee}} \right) \times EFLH_{cooling} \right) \\ + \left(kBTUh_{heating}/unit \times \left(\frac{1}{HSPF_{baseline}} - \frac{1}{HSPF_{ee}} \right) \times EFLH_{heating} \right) \end{array} \right]$$

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

$$\Delta kWh = units \times \left[\begin{array}{l} \left(tons/unit \times \left(\frac{12}{IEER_{baseline}} - \frac{12}{IEER_{ee}} \right) \times EFLH_{cooling} \right) \\ + \left(\frac{kBTUh_{heating}/unit}{3.412} \times \left(\frac{1}{COP_{baseline}} - \frac{1}{COP_{ee}} \right) \times EFLH_{heating} \right) \end{array} \right]$$

[1] AHRI Standard 340/360 – 2015
[2] Ibid.

Peak Coincident Demand Savings

$$\Delta kW = \text{units} \times \left[\text{tons/unit} \ \text{x} \left(\frac{12}{EER_{baseline}} - \frac{12}{EER_{ee}} \right) \text{x} \ CF_{cooling} \right]$$

Annual Gas Energy Savings

$\Delta therm$ = N/A

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
$\Delta therms$	= Annual gas energy savings
tons	= Output cooling capacity in tons (at AHRI standard rating conditions)
$kBTUh_{heating}$	= Output heating capacity in kBtu/h (at AHRI standard high-temperature rating conditions)
SEER	= Seasonal energy efficiency ratio in Btu/watt-hour. Total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/h, divided by the total electric energy input during the same period, in watt-hours (used only for units with cooling capacity <65,000 Btu/h)
IEER	= Integrated energy efficiency ratio in Btu/watt-hour. A weighted calculation of mechanical cooling efficiencies at full load and part load AHRI standard rating conditions (used only for units with cooling capacity ≥65,000 Btu/h)[3]
EER	= Energy efficiency ratio, measurement of cooling capacity for a unit (in Btu/hour) / electrical energy used (watts) (at AHRI standard rating conditions)
HSPF	= Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric strip heat) during the heating season / total electric energy heat pump consumed (in watt/hr) (used only for units with cooling capacity <65,000 Btu/h)
COP	= Coefficient of performance, ratio of output energy/input energy (at AHRI standard high-temperature rating conditions) (used only for units with cooling capacity ≥65,000 Btu/h)
$EFLH_{cooling}$	= Cooling equivalent full-load hours
$EFLH_{heating}$	= Heating equivalent full-load hours
$CF_{cooling}$	= Coincidence factor for cooling season
12	= kBTUh/ton of air conditioning capacity
3.412	= Conversion factor, one watt/h equals 3.412142 Btu

[3] AHRI Standard 340/360 – 2015

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application
$kBTUh_{heating}$		From application
$COP_{baseline}$		Lookup based on size category
$HSPF_{baseline}$		Lookup based on size category
COP_{ee}		From application
$HSPF_{ee}$		From application
$SEER_{baseline}$		Lookup based on size category
$EER_{baseline}$		Lookup based on size category
$IEER_{baseline}$		Lookup based on size category
$SEER_{ee}$		From application
EER_{ee}		From application
$IEER_{ee}$		From application
$EFLH_{heating}$		From application, if unknown, use equivalent full-load hours from Appendix G
$EFLH_{cooling}$		From application, if unknown, use equivalent full-load hours from Appendix G

The ***SEER*** is an estimate of the seasonal energy efficiency for an average US city for small units <65,000 BTUh cooling output. Larger units are rated by either IPLV (Integrated Part Load Value) or IEER (Integrated Energy Efficiency Ratio). For units larger than 65,000 BTUh cooling output, IEER replaces SEER in the above equation. IEER should be used in lieu of IPLV when available.

The ***EER*** is the rated full-load efficiency of the unit. It is used to estimate the efficiency of the unit under peak summer conditions.

The ***IEER*** is a weighted calculation of mechanical cooling efficiencies at full load and part load AHRI Standard Rating Conditions.

The ***COP*** is a ratio of the Heating Capacity in watts to the power input values in watts at any given set of AHRI Standard Rating Conditions. The COP is equal to the HSPF/3.412.

The ***HSPF*** is the average space heating system efficiency during the space heating season in Btu/hr-watt (for small units <65,000 BTUh cooling output).

Coincidence Factor (CF)

Recommended value for the coincidence factor in the cooling mode is 0.8.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency for unitary and packaged air conditioning and heat pump equipment is defined by International Energy Conservation Code[4] and subsequently adopted by the Energy Conservation Construction Code of New York State (ECCCNYS), and the New York City Energy Conservation Code[5] (NYCECC) as shown below:

Unitary Air Conditioners					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**ECCCNYS Minimum Efficiency**	**NYCECC Minimum Efficiency**
Air conditioners (air cooled)	< 65,000 Btu/h (single phase)	All	Split System	13.0 SEER	13.0 SEER
			Single Package	14.0 SEER	14.0 SEER
Through-the-wall (air cooled)	≤ 30,000 Btu/h (single phase)	All	Split system	12.0 SEER	12.0 SEER
			Single Package	12.0 SEER	12.0 SEER
Small-duct high-velocity (air cooled)	< 65,000 Btu/h (single phase)	All	Split System	11.0 SEER	11.0 SEER

[4] IECC 2015; Table C403.2.3(1): Minimum Efficiency Requirements: Electrically Operated Unitary Air Conditioners and Condensing Units & Table C403.2.3(2): Minimum Efficiency Requirements: Electrically Operated Unitary and Applied Heat Pumps

[5] NYCECC 2016; Table C403.2.3(1): Minimum Efficiency Requirements: Electrically Operated Unitary Air Conditioners and Condensing Units & Table C403.2.3(2): Minimum Efficiency Requirements: Electrically Operated Unitary and Applied Heat Pumps

Unitary Air Conditioners					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**ECCCNYS Minimum Efficiency**	**NYCECC Minimum Efficiency**
Air conditioners (air cooled)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 12.8 IEER	11.2 EER 12.8 IEER
		All other	Split System and Single Package	11.0 EER 12.6 IEER	11.0 EER 12.6 IEER
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 12.4 IEER	11.0 EER 12.4 IEER
		All other	Split System and Single Package	10.8 EER 12.2 IEER	10.8 EER 12.2 IEER
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 11.6 IEER	10.0 EER 11.6 IEER
		All other	Split System and Single Package	9.8 EER 11.4 IEER	9.8 EER 11.4 IEER
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 11.2 IEER	9.7 EER 11.2 IEER
		All other	Split System and Single Package	9.5 EER 11.0 IEER	9.5 EER 11.0 IEER

Unitary and Applied Heat Pumps					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**ECCCNYS Minimum Efficiency**	**NYCECC Minimum Efficiency**
Cooling					
Air cooled (cooling mode)	< 65,000 Btu/h (single phase)	All	Split System	14.0 SEER	14.0 SEER
			Single Packaged	14.0 SEER	14.0 SEER
Through-the-wall (air cooled)	≥ 30,000 Btu/h (single phase)	All	Split System	12.0 SEER	12.0 SEER
			Single Packaged	12.0 SEER	12.0 SEER
Single-duct high-velocity (air cooled)	< 65,000 Btu/h (single phase)	All	Split System	11.0 SEER	11.0 SEER

Unitary and Applied Heat Pumps					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**ECCCNYS Minimum Efficiency**	**NYCECC Minimum Efficiency**
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 12.0 IEER	11.0 EER 12.0 IEER
		All other	Split System and Single Package	10.8 EER 11.8 IEER	10.8 EER 11.8 IEER
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 11.6 IEER	10.6 EER 11.6 IEER
		All other	Split System and Single Package	10.4 EER 11.4 IEER	10.4 EER 11.4 IEER
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 10.6 IEER	9.5 EER 10.6 IEER
		All other	Split System and Single Package	9.3 EER 9.4 IEER	9.3 EER 9.4 IEER
Heating					
Air cooled (heating mode)	< 65,000 Btu/h (single phase)	—	Split System	8.2 HSPF	8.2 HSPF
		—	Single Package	8.0 HSPF	8.0 HSPF
Through-the-wall (air cooled, heating mode)	≥ 30,000 Btu/h (single phase)	—	Split System	7.4 HSPF	7.4 HSPF
		—	Single Package	7.4 HSPF	7.4 HSPF
Small-duct high velocity (air cooled, heating mode)	< 65,000 Btu/h (single phase)	—	Split System	6.8 HSPF	6.8 HSPF

Unitary and Applied Heat Pumps					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**ECCCNYS Minimum Efficiency**	**NYCECC Minimum Efficiency**
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	—	47ºF db/43ºF wb Outdoor Air	3.3 COP	3.3 COP
			17ºF db/15ºF wb Outdoor Air	2.25 COP	2.25 COP
	≥ 135,000 Btu/h	—	47ºF db/43ºF wb Outdoor Air	3.2 COP	3.2 COP
			17ºF db/15ºF wb Outdoor Air	2.05 COP	2.05 COP

Compliance Efficiency from which Incentives are Calculated

Based on program requirements.

Operating Hours

Heating and cooling Equivalent Full-Load Hours are found in Appendix G.

Effective Useful Life (EUL)

Years: 15
Source: DEER 2014[6]

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. AHRI Standard 340/360, 2015 Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment http://ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_340-360_2015.pdf

[6] California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-07-2014; EUL ID: HVAC-airAC & HVAC-airHP
Available at: http://deeresources.com/files/deerchangelog/deerchangelog.html

2. AHRI Standard 210/240, 2008 Standard for Performance Rating of Unitary Air-Conditioning & Air Source Heat Pump Equipment http://www.ahrinet.org/App_Content/ahri/files/standards%20pdfs/ANSI%20standards%20pdfs/ANSI.AHRI%20Standard%20210.240%20with%20Addenda%201%20and%202.pdf
3. IECC 2015: International Energy Conservation Code – 2015 http://codes.iccsafe.org/app/book/content/2015-I-Codes/NY/2015%20IECC%20HTML/Chapter%204%20[CE].html
4. NYCECC 2016: New York City Energy Conservation Code – 2016 https://www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
1-17-5	12/31/2016

Return to Table of Contents

AIR CONDITIONER AND HEAT PUMP –PACKAGED TERMINAL

Measure Description

Packaged Terminal Air Conditioner (PTAC) — a wall sleeve and a separate un-encased combination of heating and cooling assemblies specified by the manufacturer and intended for mounting through the wall. It includes refrigeration components, separable outdoor louvres, forced ventilation, and heating availability by purchaser's choice of, at least, hot water, steam, or electrical resistance heat.[1]

Note: Models designated as "cooling only" units need not include heating elements if the physical characteristics and arrangement of the refrigeration system are identical to those of models with heating availability.

Packaged Terminal Heat Pump (PTHP) — a separate un-encased refrigeration system installed in a cabinet having a function and configuration similar to that of a packaged terminal air-conditioner. It uses reverse cycle refrigeration as its prime heat source and should have other supplementary heat source(s) available to purchasers with the choice of, at least, hot water, steam, or electric resistance heat.[2,3]

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \text{units} \times \left[\left(kBTUh_{cooling} / \text{unit} \times \left(\frac{1}{EER_{baseline}} - \frac{1}{EER_{ee}} \right) \times EFLH_{cooling} \right) + \left(\frac{kBTUh_{heating} / \text{unit}}{3.412} \times \left(\frac{1}{COP_{baseline}} - \frac{1}{COP_{ee}} \right) \times EFLH_{heating} \right) \right]$$

Peak Coincident Demand Savings

$$\Delta kW = \text{units} \times \left[kBTUh_{cooling} / \text{unit} \ \text{x} \left(\frac{1}{EER_{baseline}} - \frac{1}{EER_{ee}} \right) \text{x} \ CF_{cooling} \right]$$

[1] AHRI Standard 310/380 – 2014; p. 13
[2] Ibid.
[3] Replacement unit shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY: NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches (406 mm) in height and less than 42 inches (1067 mm) in width.

Annual Gas Energy Savings

$\Delta therm = N/A$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
$\Delta therms$	= Annual gas energy savings
units	= Number of measures installed under the program
$kBTUh_{cooling}$	= Output cooling capacity in kBtu/h (at AHRI standard rating conditions)
$kBTUh_{heating}$	= Output heating capacity in kBtu/h (at AHRI standard high-temperature rating conditions)
EER	= Energy efficiency ratio, measurement of cooling capacity for a unit (in Btu/hour) / electrical energy used (watts) (at AHRI standard rating conditions)
COP	= Coefficient of performance, ratio of output energy/input energy (at AHRI standard high-temperature rating conditions)
$CF_{cooling}$	= Coincidence factor for cooling season
$EFLH_{cooling}$	= Cooling equivalent full-load hours
$EFLH_{heating}$	= Heating equivalent full-load hours
3.412	= Conversion factor, one watt/h equals 3.412142 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTUh_{cooling}$		From application
$kBTUh_{heating}$		From application
$COP_{baseline}$		Lookup based on size category
COP_{ee}		From application
$EER_{baseline}$		Lookup based on size category
EER_{ee}		From application
$EFLH_{heating}$		From application, if unknown, use equivalent full-load hours from Appendix G
$EFLH_{cooling}$		From application, if unknown, use equivalent full-load hours from Appendix G

The HSPF is an estimate of the seasonal heating energy efficiency for an average US city. The COP is equal to the HSPF/3.412. Programs should use the manufacturers' rated HSPF or COP until data can be developed that are more appropriate for NY climates.

Coincidence Factor (CF)

Recommended value for the coincidence factor in the cooling mode is 0.8.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiencies for new construction and normal replacement vary by equipment size, and are defined by International Energy Conservation Code[4] and subsequently adopted by the Energy Conservation Construction Code of New York State (ECCCNYS) and the New York City Energy Conservation Code[5] (NYCECC) as shown below:

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency ECCCNYS and NYCECC[6]
PTAC (Cooling Mode) Standard Size	All Capacities	95°F db Outdoor Air	14.0 - (0.300 × Cap/1000) EER
PTAC (Cooling Mode) Nonstandard Size[7]	All Capacities	95°F db Outdoor Air	10.9 - (0.213 × Cap/1000) EER
PTHP (Cooling Mode) Standard Size	All Capacities	95°F db Outdoor Air	14.0 - (0.300 × Cap/1000) EER
PTHP (Cooling Mode) Nonstandard Size	All Capacities	95°F db Outdoor Air	10.8 - (0.213 × Cap/1000) EER
PTHP (Heating Mode) Standard Size	All Capacities	—	NY State: 3.2 - (0.026 × Cap/1000) COP NYC: 3.7 – (0.052 × Cap/1000) COP
PTHP (Heating Mode) Nonstandard Size	All Capacities	—	2.9 - (0.026 × Cap/1000) COP

Compliance Efficiency from which Incentives are Calculated

Based on program minimum requirements.

Operating Hours

Cooling and Heating Equivalent Full Load Hours are found in Appendix G.

[4] IECC 2015; Table C403.2.3(3): Minimum Efficiency Requirements: Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single Package Vertical Air Conditioners, Single Vertical Heat Pumps, Room Air Conditioners and Room Air Conditioner Heat Pumps

[5] NYCECC 2016; Table C403.2.3(3): Minimum Efficiency Requirements: Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single Package Vertical Air Conditioners, Single Vertical Heat Pumps, Room Air Conditioners and Room Air Conditioner Heat Pumps

[6] "Cap" = The rated cooling capacity of the project in Btu/h. If the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculations."

[7] Nonstandard size units must be factory labeled as follows: "MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW STANDARD PROJECTS." Nonstandard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16 in. high or less than 42 in. wide and having a cross-sectional area less than 670 in.

Effective Useful Life (EUL)

Years: 15
Source: DEER 2014[8]

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. AHRI Standard 310/380 -– 2014: Standard for Packaged Terminal Air-Conditioners and Heat Pumps
http://www.ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_310_380-2014_CSA_C744-14.pdf
2. IECC 2015: International Energy Conservation Code – 2015
http://codes.iccsafe.org/app/book/content/2015-I-Codes/NY/2015%20IECC%20HTML/Chapter%204%20[CE].html
3. NYCECC 2016: New York City Energy Conservation Code – 2016
https://www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
1-17-6	12/31/2016

Return to Table of Contents

[8] California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-07-2014; EUL ID: HVAC-PTAC & HVAC-PTHP
Available at: http://deeresources.com/files/deerchangelog/deerchangelog.html

LIGHTING

INTERIOR AND EXTERIOR LAMPS AND FIXTURES

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

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta\text{kWh} = [(\text{W} \times \text{units})_{\text{baseline}} - (\text{W} \times \text{units})_{\text{ee}}]/1{,}000 \times \text{hrs}_{\text{operating}} \times (1 + \text{HVAC}_{\text{c}}) \times ISR$$

Peak Coincident Demand Savings

$$\Delta\text{kW} = [(\text{W} \times \text{units})_{\text{baseline}} - (\text{W} \times \text{units})_{\text{ee}}]/1{,}000 \times (1 + \text{HVAC}_{\text{d}}) \times ISR \times CF$$

Annual Gas Energy Savings

$$\Delta\text{therm} = [(\text{W} \times \text{units})_{\text{baseline}} - (\text{W} \times \text{units})_{\text{ee}}]/1{,}000 \times \text{hrs}_{\text{operating}} \times \text{HVAC}_{\text{g}} \times ISR$$

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

Annual Electric Energy Savings

$$\Delta\text{kWh} = \text{Area} \times [LPD_{\text{baseline}} - \text{LPD}_{\text{ee}}]/1{,}000 \times \text{hrs}_{\text{operating}} \times (1 + \text{HVAC}_{\text{c}}) \times ISR$$

Peak Coincident Demand Savings

$$\Delta\text{kW} = Area \times [LPD_{\text{baseline}} - LPD_{\text{ee}}]/1{,}000 \times (1 + \text{HVAC}_{\text{d}}) \times ISR \times CF$$

Annual Gas Energy Savings

$$\Delta\text{therm} = Area \times [LPD_{\text{baseline}} - \text{LPD}_{ee}]/1{,}000 \times \text{hrs}_{\text{operating}} \times \text{HVAC}_{\text{g}} \times ISR$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
Δtherm = Annual gas energy savings
units = Number of units
CF = Coincidence factor
$_{ee}$ = Energy efficient condition or measure
$_{baseline}$ = Baseline condition or measure
Area = Extent of space or surface in square feet
1,000 = Conversion factor, one kW equals 1,000 watts
$LPD_{baseline}$ = Lighting power density in watts/square feet, see Table.
LPD_{ee} = Lighting power density in watts/square feet
W = Watts
$hrs_{operating}$ = Lighting operating hours
ISR = In Service Rate, or percentage of units rebated that actually get used.
$HVAC_c$ = HVAC interaction factor for annual electric energy consumption
HVACd = HVAC interaction factor at utility summer peak hour
$HVAC_g$ = HVAC interaction factor for annual natural gas consumption

Summary of Variables and Data Sources

Variable	Value	Notes
$Units_{baseline}$	From application	Number of baseline measures, from application, set equal to $Units_{ee}$ if unknown
$Units_{ee}$	From application	Number of energy efficient measures installed under the program, from application.
W_{ee}	From application	Connected load of the energy-efficient unit, from application (in watts)
$W_{baseline}$	From application	Connected load of the baseline unit(s) displaced, from application (in watts)
$hrs_{operating}$	From application	Lighting operating hours. From application or default, as listed below in the Operating Hours table.
$LPD_{baseline}$	See Table	Lighting power density (W/SF) for baseline measure, from application, based on NY State Energy Conservation code. New construction or major renovation only.
LPD_{ee}	From application	Lighting power density (W/SF) for energy efficient measure, from application, based on installed system design. New construction or major renovation only.
Area	From application	Floor area illuminated by lighting system in square feet
$HVAC_d$	See Appendix D	HVAC interaction factor at utility summer peak hour, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.

Variable	Value	Notes
$HVAC_c$	See Appendix D	HVAC interaction factor for annual electric energy consumption, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
$HVAC_g$	See Appendix D	HVAC interaction factor for annual natural gas consumption, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
ISR	98%	In Service Rate, percentage of rebated equipment that is installed. Assume 98% for prescriptive programs if application does not confirm equipment placed in storage.
CF	1.0 Interior 0.0 Exterior	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

$Watts_{ee}$ is defined as the fixture wattage of the efficient lighting fixture. See table of standard fixture wattages in Appendix C. Manufacturers' cut sheet data for fixture watts can be substituted for the typical values in Appendix C if available.

$Watts_{baseline}$ is defined as the fixture wattage of the baseline lighting fixture. The baseline condition is assumed to be the existing and operational lighting fixture in all applications other than new construction or extensive renovations that trigger the building code. See table of standard fixture wattages in Appendix C.

Code LPD shall be taken from New York State Energy Conservation Code that is based on ASHRAE 90.1-2007. Use the appropriate LPD based on the building type or space occupancy as applicable.

Coincidence Factor (CF)
Defined as the ratio of the peak lighting demand operating at the time of the system peak to the connected load. Because not all of the fixtures in the population are operating at all times, the peak lighting demand is often less than the connected load. Occupant control of the lighting systems and burned-out lamps cause some portion of the fixtures to be non-operational. In lighting retrofit programs, the pre-retrofit (baseline) demand diversity factor is often lower than the post-retrofit demand diversity factor, due to burned out lamps that are replaced as part of the program.

For many utilities, summer peak demand occurs in the afternoon, indicating a recommended value for the coincidence factor for interior lighting is 1.0, and since exterior lighting is generally off during daylight hours, the recommended value is 0.0.

The ***HVAC system interaction factor*** is defined as the ratio of the cooling energy reduction per unit of lighting energy reduction. Most of the input energy for lighting systems is converted to heat that must be removed by the HVAC system. Reductions in lighting heat gains due to lighting power reduction decrease the need for space cooling and increase the need for space heating. HVAC interaction factors vary by climate, HVAC system type and building type. Recommended values for HVAC interaction factors for lighting energy and peak demand savings are shown in Appendix D. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0. The building types for the HVAC interactive effect factors by facility type are shown in the lighting Operating Hours table below.

Baseline Efficiencies from which Savings are Calculated

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

Compliance Efficiency from which Incentives are Calculated

Efficient lighting fixtures as defined by the program. See table of standard fixture wattages in Appendix C. Manufacturers' cut sheets may substitute for the standard fixture watts in Appendix C if available. In new construction or major renovation projects, the new lighting system power consumption should be expressed as a lighting power density (LPD) in watts per square foot.

On July 14, 2009 the Department of Energy published a final rule for energy conservation standards for general service fluorescent lamps (GSFLs). These standards went into effect on July 14, 2015 and eliminate the manufacture of T12 lamps.

Lamp Type	Nominal Lamp Wattage	Minimum Color Rendering Index (CRI)	Minimum Average Lamp Efficacy (Lumens/Watt, or LPW)
4-foot Medium Bi-Pin	> 35W	69	75.0
	≤ 35 W	45	75.0
2-foot U-Shaped	> 35W	69	68.0
	≤ 35W	45	64.0
8-foot Slimline	> 65W	69	80.0
	≤ 65W	45	80.0
8-foot High Output	> 100W	69	80.0
	≤ 100W	45	80.0

Operating Hours

The average ***lighting operating hours*** are defined by building type, as shown in the table below. These are typical average values for the building types shown. Use building specific operating hours where available.

Facility Type	Lighting Hours (hrs/yr)	HVAC Int	Facility Type	Lighting Hours (hrs/yr)	HVAC Int
Auto Related*	2,810	AR	Manufacturing Facility	2,857	Ind
Automotive / Transportation Service or Repair Facility (24/7)	8,760	AR	Medical Offices	3,748	SOfc
Bakery	2,854	FS	Motion Picture Theatre	1,954	Asy
Banks	3,748	SOfc	Multi-Family (Common Areas)	7,665	MFL
Church	1,955	Rel	Museum	3,748	Asy
College– Cafeteria (1)	2,713	FS	Nursing Homes	5,840	MFL
College – Classes	2,586	CC	Office (General Office Types) (1)	3013	SOfc/ LOfc
College - Dormitory	3,066	Dorm	Parking Garages	4,368	None
Commercial Condos (2)	3,100	SOfc	Parking Garages (24/7)	7,717	None
Convenience Stores	6,376	SRet	Parking Lots	4,100	None
Convention Center	1,954	Asy	Penitentiary	5,477	MFL
Court House	3,748	LOfc	Performing Arts Theatre	2,586	Asy
Dining: Bar Lounge/Leisure	4,182	FS	Police / Fire Stations (24 Hr)	7,665	Asy
Dining: Cafeteria / Fast Food	6,456	FF	Post Office	3,748	SRet
Dining: Family	4,182	FS	Pump Stations	1,949	Ind
Entertainment	1,952	Asy	Refrigerated Warehouse	2,602	RWH
Exercise Center	5,836	SRet	Religious Building	1,955	Rel
Fast Food Restaurants	6,376	FF	Restaurants	4,182	FS
Fire Station (Unmanned)	1,953	Asy	Retail	3,463	SRet/ LRet
Food Stores	4,055	Gro	School / University	2,187	Univ
Gymnasium	2,586	Asy	Schools (Jr./Sr. High)	2,187	HS
Hospitals	7,674	Hosp	Schools (Preschool/Elementary)	2,187	Sch
Hospitals / Health Care	7,666	Hosp	Schools (Technical/Vocational)	2,187	CC
Industrial - 1 Shift	2,857	Ind	Small Services	3,750	SOfc
Industrial - 2 Shift	4,730	Ind	Sports Arena	1,954	Asy
Industrial - 3 Shift	6,631	Ind	Town Hall	3,748	Asy
Laundromats	4,056	SRet	Transportation	6,456	Asy
Library	3,748	LOfc	Warehouse (Not Refrigerated)	2,602	WH
Light Manufacturers (1)	2,613	Ind	Waste Water Treatment Plant	6,631	Ind
Lodging (Hotels/Motels)	3,064	Hotel/ Motel	Workshop	3,750	Ind
Mall Concourse	4,833	LRet			

* New car showrooms and Big Box retail stores with evening and/or weekend hours should use the Facility Type "Retail" for lighting operating hours.

(1) Lighting operating hours data from the 2008 California DEER Update study

(2) Lighting operating hours data for offices used

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements. Interactions with the heating system must be applied to the calculations as shown in the equations above.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases space cooling requirements. Interactions with the cooling system must be applied to the calculations as shown in the equations above.

References

1. Lighting operating hour data taken from the CL&P and UI Program Savings Documentation for 2008 Program Year, with exceptions as noted.
2. Additional lighting operating hour data taken from 2008 DEER Update – Summary of Measure Energy Analysis Revisions, August, 2008. Available at www.deeresources.com
3. Small Business Direct Install Program Evaluation Review, Prepared for the New York State Department of Public Service-E^2 Working Group, by the Small Commercial EM&V Review subcommittee, April 3, 2015
4. 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

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
6-15-4	6/1/2015
1-16-6	12/31/2015
1-17-7	12/31/2016

Return to Table of Contents

APPENDIX P

EFFECTIVE USEFUL LIFE (EUL)

SINGLE AND MULTI-FAMILY RESIDENTIAL MEASURES

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Appliance	Advanced Power Strips	Residential	8	DEER 2014 EUL ID: Plug-OccSens
	Clothes Washer	Single-family	11	DEER 2014 EUL ID: Appl-EffCW
		Multi-family	14	DOE 2014
	Dehumidifier	Residential	12	US EPA[1]
	Dishwasher	Residential	11	DEER
	Refrigerator Replacement	Residential	17	NYS DPS
Appliance Recycling	Air Conditioner - Room (RAC), Recycling	Residential	3	DEER[2]
	Refrigerator Recycling	Residential	5	DEER[3]
	Freezer Recycling	Residential	4[4]	DEER[5]
Building Shell	Air Leakage sealing	Residential	15	GDS[6]
	Hot Water Pipe Insulation	Residential	13 – Electric 11 – Natural Gas	DEER
	Opaque Shell Insulation	Residential	30	Energy Trust of Oregon and CEC[7]
	Window & Through the wall AC cover and Gap Sealer	Residential	5	See note below[8]
	Windows Replacement	Residential	20	DEER
Domestic Hot Water	Domestic Hot Water Tank Blanket	Residential	10	NYSERDA[9]
	Heat Pump Water Heater – Air Source (HPWH)[10]	Residential	10	DEER[11]
	Indirect Water Heater	Residential	13	DEER[12]
	Storage Tank Water Heater	Residential	15	DEER
	Instantaneous Water Heater	Residential	20	DEER

[1] ENERGY STAR Dehumidifier Calculator www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls
[2] IBID
[3] DEER 2008 RUL assumptions, based on 1/3 of DEER EUL
[4] The hypothetical remaining years of use in the absence of removal of the appliance by the program
[5] DEER 2008 RUL assumptions, based on 1/3 of DEER
[6] IBID
[7] http://energytrust.org/library/reports/resource_assesment/gasrptfinal_ss103103.pdf
[8] At least one manufactures warranty period. www.gss-ee.com/products.html
[9] NYSERDA Energy Smart Program Deemed Savings Database. Rev 9 – 062006
[10] Electric heat pump used for service hot water heating
[11] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning from the California DEER website: www.deerurces.com
[12] Based on EUL of unfired (electric) water heater tank from DEER

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Domestic Hot Water - Control	Faucet- Low flow Aerator	Residential	10	DEER
	Shower Restriction Valve	Residential	9	UPC[13]
	Shower Head – Low flow	Residential	10	DEER
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner and Heat pump – Refrigerant charge correction	Residential	10	DEER
	Air Conditioner and Heat pump – Right sizing	Residential	15	DEER[14]
	Air Conditioner, Central (CAC)	Residential	15	DEER[15]
	Air Conditioner – Room (RAC)	Residential	9	DEER
	Boiler	Residential	25	Efficiency VT[16]
	Circulator – with Electronically Commuted Motor (ECM) for Hydronic distribution	Residential	15	DEER[17]
	Duct sealing and Insulation	Residential	18	DEER
	Fan Motor – with Electronically Commuted Motor (ECM) for Furnace Distribution	Residential	15	DEER
	Furnace	Residential	20	DEER
	Furnace Tune-up	Residential	5	See note below[18]
	Heat Pump - Air Source (ASHP)	Residential	15	DEER[19]
	Heat Pump – Ground Source (GSHP)	Residential	20	US DOE
HVAC - Control	Outdoor Reset Control for Hydronic Boiler	Residential	15	ACEEE[20]
	Thermostat – Programmable Setback	Residential	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve	Multi-family	12	NYS DPS

[13] 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.
[14] Savings assumed to persist over EUL of air conditioner or heat pump
[15] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning. From the California DEER website: www.deeresidentialsources.com
[16] Efficiency Vermont Technical Reference Manual, ver. 4
[17] Based on DEER value for furnace fans
[18] Reduced from DEER value of 10 years
[19] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning. From the California DEER website: www.deeresidentialsources.com
[20] Potential for Energy Efficiency, Demand Response and Onsite Solar Energy in Pennsylvania, ACEEE report number E093. April 2009

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
Lighting	Compact Fluorescent Lamp (CFL)		Residential	Coupon – 5	GDS
				Direct Install – 7	GDS
				Markdown - 7	GDS
			Multi-family Common area	9,000 hrs/ annual lighting operating hrs	See note below[21]
	LED Lamps (Directional)		Residential/ Multi-family Common area	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Lamps[22]
				35,000 or 50,000 hours	DLC[23]
	LED Lamps (Decorative & Omnidirectional)		Residential/ Multi-family Common area	15,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Lamps
	Light Fixture	LED (Interior)	Residential/ Multi-family	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Fixtures[24]
		LED (Exterior)	Residential/ Multi-family Common area	35,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Fixtures
		Linear Fluorescent	Residential / Multi-family Common area	70,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	DEER 2014[25] EUL ID: ILtg-Lfluor-CommArea

[21] 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

[22] 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

[23] 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

[24] 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

[25] Basis value 70,000 hours, capped at 20 years, is common given redecoration patterns

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
		CFL	Residential / Multi-family Common area	22,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	See note below[26]
Lighting Control	Stairwell Dimming Light Fixture/Sensor		Multi-family	12	GDS[27]

[26] Basis value 22,000 hour ballast life per US EPA. Capped at 20 years as above (2.5 hours per day average lamp operation)

[27] GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group

COMMERCIAL AND INDUSTRIAL MEASURES

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Agricultural	Engine Block Heater Timer	C&I	8	See note below[28]
Appliance	Electric Cooking Equipment (Oven, Fryer, Steamer)	C&I	12	DEER
	Gas Fired Cooking Equipment (Oven, Griddle, Fryer, Steamer)	C&I	12	DEER
	Refrigerator Replacement	C&I	12	DEER
Appliance Control	Vending Machine/ Novelty Cooler Time clock	C&I	5	DEER
Building Shell	Cool Roof	C&I	15	DEER
	Hot Water Pipe Insulation	C&I	13 – Electric 11 – Natural Gas	DEER
	Window - Film	C&I	10	DEER
	Window - Glazing	C&I	20	DEER
	Opaque Shell Insulation	C&I	30	Energy Trust and CEC[29]
Compressed Air	Air Compressor Upgrade	C&I	15	Ohio TRM[30]
	Refrigerated Air Dryer	C&I	15	Ohio TRM
	Engineered Air Nozzle	C&I	15	PA Consulting for Wisconsin PSC[31]
	No Air Loss Water Drain	C&I	15	Ohio TRM[32]
Domestic Hot Water (DHW)	Domestic Hot Water Tank Blanket	C&I	7	DEER
	Indirect Water Heater	C&I	15	DEER[33]
	Storage Tank Water Heater	C&I	15	DEER
	Tankless Water Heater	C&I	20	DEER
	Heat Pump Water Heater - Air Source (HPWH)	C&I	10	DEER
DHW - Control	Faucet- Low Flow Aerator	C&I	10	DEER
	Showerhead – Low Flow	C&I	10	DEER
	Pre-rinse Spray Valve	C&I	5	GDS

[28] Based on EUL's for similar control technology

[29] Energy Trust uses 30 years for commercial applications. http://energytrust.org/library/reports/Residentialource_assesment/gasrptfinal_ss103103.pdf. CEC uses 30 years for insulation in Title 24 analysis

[30] Ohio Technical Reference Manual (TRM). Based on a review of TRM assumptions from Vermont, New Hampshire, Massachusetts, and Wisconsin. Estimates range from 10 to 15 years. www.OhioTRM.org

[31] PA Consulting Group (2009). *Business Programs: Measure Life Study*. Prepared for State of Wisconsin Public Service Commission

[32] EUL for this measure not available. Default to air compressor upgrade EUL from Ohio TRM. www.OhioTRM.org

[33] EUL for commercial central water heater used

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)				
	Air Conditioner and Heat Pump – Refrigerant Charge Correction	C&I	10	DEER
	Air Conditioner – Package (PTAC)	C&I	15	DEER 2014 EUL ID: HVAC-airAC
	Chiller – Air & Water cooled	C&I	20	DEER
	Chiller – Cooling Tower	C&I	15	DEER
	Combination Boiler and Water Heater	C&I	20	DEER[34]
	Condensing Gas-Fired Unit Heater for space heating	C&I	18	Ecotope[35]
	Duct Sealing and Insulation	C&I	18	DEER
	ECM Motors on HVAC Equipment, including fan powered terminal boxes, fan coils, and HVAC supply fans.	C&I	15	DEER[36]
	Economizer – Air Side, w/dual enthalpy control	C&I	10	DEER
	Furnace and Boiler	C&I	20	DEER
	Heat Pump – Air Source, Package (PTHP)	C&I	15	DEER 2014 EUL ID: HVAC-airHP
	Infrared Gas Space Heater	C&I	17	GDS
HVAC - Control	Thermostat – Programmable Setback	C&I	11	DEER
	Boiler Reset Control	C&I	15	See note below[37]
	Demand Controlled Ventilation	C&I	10	DEER
	Energy Management System	C&I	15	DEER
	Hotel Occupancy Sensors for PTAC and HP Units	C&I	8	DEER[38]
	Steam Traps Repair/Replace	C&I	6	DEER

[34] Based on DEER value for high efficiency boiler
[35] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003)
[36] DEER value for HVAC fan motors
[37] Set to 15 years, consistent with Energy Management System (EMS) value in DEER
[38] DEER value for occupancy sensor controls. Hardwired (not battery powered) controls only

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting	CFL Lamp	C&I	9,000 hours /annual lighting operating hours	See note below[39]
	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[40] EUL ID: ILtg-Lfluor-Elec
	LED Fixtures (other than refrigerated case)	C&I	35,000 or 50,000 hours	DLC[41]
			35,000 hours /annual lighting operating hours or 20 years (whichever is less)	Energy Star[42]
			25,000 hours /annual lighting operating hours or 20 years (whichever is less)	Uncertified
	Refrigerated Case LED	C&I	6	NW RTF[43]

[39] Based on reported annual lighting operating hours; default value by space type in the technical manual (pp. 109-110)
[40] Basis Value 70,000 hours, capped at 15 years to reflect C&I redecoration and business type change patterns
[41] 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
[42] 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 15 years regardless (consistent with C&I redecoration and business type change patterns
[43] Northwest Regional Technical Forum (RTF) value

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
	LED Screw-In Lamps	C&I	15,000 hours (decorative) or 25,000 hours (all other)/ annual lighting operating hours or 20 years (whichever is less)	Energy Star
Lighting - Control	Interior & Exterior Lighting Control	C&I	8	DEER
	Stairwell Dimming Light Fixture/Sensor	C&I	12	GDS[44]
	Plug-Load Occupancy Sensor	C&I	8	DEER[45]
Motors and drives	Motor replacement (with HE motor)	C&I	15	DEER
	Variable Frequency Drive – Fan and Pump	C&I	15	DEER
Refrigeration	Air Cooled Refrigeration Condenser	C&I	15	DEER
	Equipment (Condensers, Compressors, and Sub-cooling)	C&I	15	DEER
	Fan Motor – Refrigerated Case and Walk-In Cooler, with ECM	C&I	15	DEER
	Refrigerated Case Night Cover	C&I	5	DEER
	Auto/Fast Close Door Walk-In Coolers/Freezers	C&I	8	DEER
	Strip Curtains and Door Gaskets for Reach-In or Walk-In Coolers/Freezers	C&I	4	DEER
Refrigeration - Control	Anti-Condensation Heater control	C&I	12	DEER
	Evaporator Fan Control	C&I	16	DEER
	Condenser Pressure and Temperature Controls	C&I	15	DEER

Record of Revision

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

Return to Table of Contents

[44] GDS Associates, Inc. (2007). Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures. Prepared for The New England State Program Working Group

[45] DEER value for lighting occupancy sensors

GLOSSARY

ABBREVIATIONS, ACRONYMS, AND EQUATION VARIABLES	
$\overline{COP}$	Average coefficient of performance
η	Energy efficiency (0 -100%)
$\overline{\eta}$	Average energy efficiency (0 -100%)
$\overline{\Delta T}$	Average temperature difference
$\overline{EER}$	Seasonal average energy efficiency ratio over the cooling season BTU/watt-hour, (used for a particular climate/building)
Δ kW	Peak coincident demand electric savings
Δ kWh	Annual electric energy savings
Δ Q	Heat difference/loss
Δ T	Temperature difference
Δ therms	Annual gas energy savings
Δ	Change, difference, or savings
A	Amperage
AC	Air conditioning
ACCA	Air Conditioning Contractors of America
ACEEE	American Council for an Energy-Efficient Economy
ACH	Air change per hour
AFUE	Annual fuel utilization efficiency, seasonal energy efficiency for fuel heating equipment
AHAM	Association of Home Appliance Manufacturers
AHRI	Air Conditioning Heating and Refrigeration Institute
AHU	Air handling unit
AIA	American Institute of Architects
ANSI	American National Standards Institute
APU	Auxiliary power unit
area	Extent of space or surface
ARI	Air-Conditioning & Refrigeration Institute
ARRA	American Recovery and Reinvestment Act of 2009
ASHP	Air source heat pump
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
BLDC	Brushless DC electric motor
BTU	British Thermal Unit
BTUh	British Thermal Units per hour
CAC	Central air conditioner
CAV	Constant air volume
CBECS	Commercial Buildings Energy Consumption Survey
CDD	Cooling degree days
CEC	State of California Energy Commission
CEE	Consortium for Energy Efficiency
CF	Coincidence factor
CFL	Compact fluorescent lamp

CFM	Cubic foot per minute
CHW	Chilled water
CHWP	Chilled water pump
CLH	Cooling load hours
CMU	Concrete masonry
COP	Coefficient of performance, ratio of output energy/input energy
CV	Constant volume
CW	Condenser water
CWP	Condenser water pump
D	Demand
DC	Direct current
DCV	Demand controlled ventilation
DEER	Database for Energy Efficiency Resources, California
DF	Demand diversity factor
DFP	Default functional period
DHW	Domestic hot water
DLC	DesignLights Consortium®
DOAS	Dedicated outdoor air system
DOE 2.2	US DOE building energy simulation, and cost calculation tool
DPS	Department of Public Service, New York State
DSF	Demand savings factor
DX	Direct expansion
ECCC NYC	Energy Conservation Construction Code of New York City
ECCC NYS	Energy Conservation Construction Code of New York State
EC	Electronically commutated
Econ	Economizer
Ecotope	Ecotope Consulting, Redlands, CA
EEPS	Energy Efficiency Portfolio Standard
EER	Energy efficiency ratio under peak conditions
EF	Energy factor
Eff	Efficiency
Eff_c	Combustion efficiency
Efficiency Vermont	State of Vermont Energy and Efficiency Initiatives
Eff_t	Thermal efficiency
EFLH	Equivalent full-load hours
EIA	Energy Information Administration, US
EISA	Energy Independence and Security Act (EISA) of 2007
ElecSF	Electric Savings Factor
ENERGY STAR®	U.S. Environmental Protection Agency voluntary program
Energy Trust	Energy Trust of Oregon, Inc.
EPA	Environmental Protection Agency (EPA), US
EPACT	Energy Policy and Conservation Act of 2005

EPDM	Ethylene propylene diene monomer roofing membrane
ERV	Energy recovery ventilation
ESF	Energy savings factor
EUL	Effective useful life
$Evap_{fan}$	Evaporator fan
Exh	Exhaust
F	Savings factor
FEMP	Federal Energy Management Program
FLH	Full-load hours
FLOW	Nozzle flow
FPFC	Four pipe fan coil
ft^2	Square foot
GasSF	Gas Savings Factor
GDS	GDS Associates, Marietta, GA
Glazing area	Aperture area of glazing
GPD	Gallons per day
GSHP	Ground source heat pump
HDD	Heating degree day - The number of degrees that a day's average temperature is below 65° Fahrenheit. The temperature below which buildings need to be heated.
HID	High intensity discharge lamp
hp	Horsepower
HP	High performance
hrs	hours
$hrs_{operating}$	Operating hours
HSPF	Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric heat) during the heating season / total electric energy heat pump consumed (in watt/hr)
ht	Height
HVAC	Heating, ventilation, and air conditioning
$HVAC_c$	HVAC interaction factor for annual electric energy consumption
$HVAC_d$	HVAC interaction factor at utility summer peak hour
$HVAC_g$	HVAC interaction factor for annual natural gas consumption
HW	Hot water
IECC	International Energy Conservation Code
IEER	Integrated energy efficiency ratio
IESNA	Illuminating engineering Society of North America
IPLV	Integrated Part-Load Value, a performance characteristic, typically of a chiller capable of capacity modulation.
k	Thermal conductivity
$KBTUh_{input}$	Annual gas input rating
$kBTUh_{output}$	Annual gas output rating
kW	Kilowatt
L	Length
LBNL	Lawrence Berkeley National Laboratory

leakage	Estimate of percent of units not installed in service territory
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LPD	Lighting power density
LRAC	Long-run avoided cost
LSAF	Load shape adjustment factor
MEC	Metropolitan Energy Center
NAECA	National Appliance Energy Conservation Act of 1987
NBI	New Buildings Institute
NEA	National Energy Alliances
NEAT	National Energy Audit Tool
NEMA	National Electrical Manufacturers Association
NREL	National Renewable Energy Laboratory
NRM	National Resource Management
NSTAR	Operating company of Northeast utilities
NWPPC	Northwest Power Planning Council
NWRTF	Northwest Regional Technical Forum
NY DPS	New York State Department of Public Service
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
^{o}F	Degrees Fahrenheit
OSA	Outdoor supply air
PA Consulting	PA Consulting Group
PF	Power factor
Phase	Number of phases in a motor (1 or 3) Single Phase is a type of motor with low horsepower that operates on 120 or 240 volts, often used in residential appliances. Three phase is a motor with a continuous series of three overlapping AC cycles offset by 120 degrees. Three-phase is typically used in commercial applications.
PLR	Power loss reduction
PNNL	Pacific Northwest National Laboratory
PSC	Public Service Commission, New York State
PSF	Proper sizing factor
PSZ	Packaged single zone
PTAC	Package terminal air conditioner
PTHP	Packaged terminal heat pump
Q	Heat
$Q_{reduced}$	Reduced heat
Q_{reject}	Total heat rejection
r	Radius
RA	Return air
RAC	Room air conditioner
RE	Recovery efficiency
RECS	Residential Energy Consumption Survey

RESNET	Residential Energy Services Network
RH	Reduced heat
RLF	Rated load factor
RPM	Revolutions per minute
R-value	A measure of thermal resistance particular to each material
S	Savings
SAPA	State Administrative Procedure Act
SBC	System Benefit Charge
SCFM	Standard cubic feet per minute @ 68 ^{o}F and 14.7 psi standard condition
SEER	Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
sf	Square foot
SHGC	Solar heat gain coefficient
SL	Standby heat loss
Staff	NYS Department of Public Service Staff
T	Temperature
TAF	Temperature adjustment factor
TEFC	Totally enclosed fan cooled
th	Thickness
therm	Unit of heat
THR	Total heat rejection
TMY	Typical meteorological year
tons	Tons of air conditioning
tons/unit	Tons of air conditioning per unit, based on nameplate data
TRC	Total Resources Cost
TRM	Technical Resource Manual
UA	Overall heat loss coefficient (BTU/hr-°F)
unit	Measure
units	Number of measures installed under the program
UPC	Uniform Plumbing Code under the International Association of Plumbing and Mechanical Officials
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
U-value	Measure of heat loss in a building element/overall heat transfer co-efficient
V	Volt
v	Volume
VAV	Variable air volume
VSD	Variable speed drive
W	Watts
w	Width
Wisconsin PSC	State of Wisconsin Public Service Commission

EQUATION CONVERSION FACTORS	
0.000584	Conversion factor used in DOE test procedure
0.00132	Electric efficient storage type water heater replacing standard storage tank water heater. NAECA referenced as function of storage volume.
0.0019	Natural gas efficient storage type water heater replacing standard storage tank water heater. NAECA referenced as function of storage volume.
0.285	Conversion factor, one kW equals 0.285388 ton
0.293	Conversion factor, one BTU/h equals 0.293071 watt
0.67	Natural gas water heater Energy Factor
0.746	Conversion factor (kW/hp), 0.7456999 watts equals one electric horsepower
0.97	Electric resistance water heater Energy Factor
1.08	Specific heat of air × density of inlet air @ 70^{o}F × 60 min/hr
1.6	Typical refrigeration system kW/ton
3.517	Conversion factor, one ton equals 3.516853 kilowatts
8.33	Energy required (BTU's), to heat one gallon of water by one degree Fahrenheit
12	kBTUh/ton of air conditioning capacity
67.5	Ambient air temperature °F
91	Days in winter months
274	Days in non-winter months.
365	Days in one year
3.412	Conversion factor, one watt/h equals 3.412142 BTU
3,412	Conversion factor, one kWh equals 3,412 BTU
8,760	Hours in one year
12,000	Conversion factor, one ton equals 12,000 BTU/h
1,000	conversion factor, one kW equals 1,000 Watts
100,000	conversion factor, (BTU/therm), one therm equals 100,000 BTU's

Record of Revision

Record of Revision Number	Issue Date
0	12/10/2014
6-15-4	6/1/2014
1-17-9	12/31/2016

Return to Table of Contents