Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
12-17-1	R	12/31/2017	1/1/2019	R/MF - Clothes Dryer	Updated measure description and key variable values to align with current ENERGY STAR requirements and federal standards. Revised formulas. Updated footnotes and references. Added description of ancillary HVAC impacts. Moved EUL information to Appendix P.	Pg. 11
12-17-2	R	12/31/2017	1/1/2019	R/MF - Refrigerator and Freezer Recycling	Updated measure description. Revised formulas. Revised deemed savings to align with conducted NY evaluations. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 34
12-17-3	R	12/31/2017	1/1/2019	R/MF - Heat Pump Water Heater (HPWH) -Air Source	Updated measure description and key variable values to align with federal standards and other relevant resources. Significantly revised methodology. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 58
12-17-4	R	12/31/2017	1/1/2019	R/MF - Indirect Water Heater	Updated measure description and key variable values to align with federal standards and other relevant resources. Revised heat loss coefficient derivation methodology. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 62
12-17-5	R	12/31/2017	1/1/2019	R/MF - Storage Tank and Instantaneous Domestic Water Heater	Updated measure description and key variable values to align with federal standards and other relevant resources. Revised heat loss coefficient derivation methodology. Reflected shift from EF to UEF. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 69

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
12-17-6	R	12/31/2017	1/1/2019	R/MF - Air Conditioner - Central (CAC)	Updated measure description and key variable values to align with federal standards and other relevant resources. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 91
12-17-7	R	12/31/2017	1/1/2019	R/MF - Blower Fan – with Electronically Commutated (EC) Motor for Furnace Distribution	Updated measure description. Added peak demand savings methodology. Revised deemed savings values to align with referenced study. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 105
12-17-8	R	12/31/2017	1/1/2019	R/MF - Heat Pump - Air Source (ASHP)	Updated measure description and key variable values to align with federal standards and other relevant resources. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 121
12-17-9	R	12/31/2017	1/1/2019	C/I - Air Compressor	Updated measure description. Removed Load/Unload option from eligible control types. Moved EUL information to Appendix P.	Pg. 180
12-17-10	R	12/31/2017	1/1/2019	C/I - Storage Tank Water Heater	Updated measure description and key variable values to align with federal standards and other relevant resources. Revised heat loss coefficient derivation methodology. Updated assumed GPD table. Revised Ancillary HVAC Impacts sections. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 194
12-17-11	R	12/31/2017	1/1/2019	C/I - Unitary Air Conditioner and Unitary & Applied Heat Pump	Updated measure description and key variable values to align with federal standards, NYS/NYC Code and other relevant resources. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 212
12-17-12	R	12/31/2017	1/1/2019	C/I - Chiller – Cooling Tower	Updated measure description. Moved EUL information to Appendix P.	Pg. 223

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
12-17-13	R	12/31/2017	1/1/2019	C/I - Furnace and Boiler	Updated measure description and key variable values to align with NYS/NYC Code and other relevant resources. Removed Compliance Efficiency table. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 235
12-17-14	R	12/31/2017	1/1/2019	C/I - Air Conditioner and Heat Pump – Packaged Terminal	Updated measure description and key variable values to align with federal standards, NYS/NYC Code and other relevant resources. Updated footnotes and references. Moved EUL information to Appendix P.	Pg. 246
12-17-15	A	12/31/2017	1/1/2018	C/I - Clothes Dryer		
12-17-16	A	12/31/2017	1/1/2018	C/I - Advanced Power Strip		
12-17-17		12/31/2017	1/1/2019	Appendix P	Updated EUL entries for all measures contained in this Record of Revision.	Pg. 577
12-17-18		12/31/2017	1/1/2019	Glossary	Added entries to align with all measures contained in this Record of Revision.	Pg. 588

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between October 1, 2017 – December 31, 2017.

CLOTHES DRYER

Measure Description

This measure covers residential grade clothes dryers meeting the criteria established under the ENERGY STAR® Program, Version 1.1, effective May 5, 2017 installed in residential settings.[1] ENERGY STAR® clothes dryers have a higher combined energy factor (CEF), and save energy through a combination of more efficient drying and reduced runtime of the drying cycle. More efficient drying is achieved through increased insulation, modifying operating conditions, improving air circulation, and improved efficiency of motors. Reduced dryer runtime is achieved through automatic termination of the dryer cycles based on temperature and moisture sensors. Clothes dryers originally qualified for the ENERGY STAR® label in May 2014. Clothes dryers that have earned this label are approximately 20% more efficient than non-qualified models.[2]

This measure applies to clothes dryers installed in single family homes and in-unit multifamily equipment. For residential grade clothes dryers installed in multifamily common areas, the Commercial and Industrial Clothes Dryer measure prescribed in the NY TRM shall be used.

The algorithms, inputs, and savings presented below assume a normal replacement scenario.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times Cycles_{annual} \times Load \times \left[\frac{F_{elec,baseline}}{CEF_{baseline}} - \frac{F_{elec,ee}}{CEF_{ee}}\right]$$

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = units \times Cycles_{annual} \times Load \times \left[\frac{F_{gas,baseline}}{CEF_{baseline}} - \times \frac{F_{gas,ee}}{CEF_{ee}}\right] \times \frac{3{,}412}{100{,}000}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
$Cycles_{annual}$	= Number of dryer cycles per year
Load	= Average total weight (lbs) of clothes per drying cycle

[1] ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017

[2] Efficiency of ENERGY STAR® products: https://www.energystar.gov/products/appliances/clothes_dryers

$_{baseline}$ = Baseline condition or measure
$_{ee}$ = Energy efficient condition or measure
F_{elec} = Percentage of energy consumed that is derived from electricity
F_{gas} = Percentage of energy consumed that is derived from gas
CEF = Combined energy factor (lb/kWh)
hrs = Annual run hours of clothes dryer
CF = Coincidence Factor
3,412 = Conversion factor, one kWh equals 3,412 BTU
100,000 = Conversion factor (BTU/therm), one therm equals 100,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
$Cycles_{annual}$		Lookup based on proposed dryer type in table below.[3]
Load		Lookup based on proposed dryer type in table below.[4]
$F_{elec,baseline}$		Lookup based on proposed dryer type in table below.[5]
$F_{elec,ee}$		Lookup based on proposed dryer type in table below.[6]
$F_{gas,baseline}$		Lookup based on proposed dryer type in table below.[7]
$F_{gas,ee}$		Lookup based on proposed dryer type in table below.[8]
$CEF_{baseline}$		Lookup based on proposed dryer type in table below.[9]
CEF_{ee}		Lookup based on proposed dryer type in table below.[10]
hrs		Lookup based on proposed dryer type in table below.[11]
CF	0.042	

Key Variables Lookup Table

Variable	Dryer Type				
	Vented Gas Dryer	*Ventless or Vented Electric, Standard ≥ 4.4 ft^3*	*Ventless or Vented Electric, Compact (120V) < 4.4 ft^3*	*Vented Electric, Compact (240V) < 4.4 ft^3*	*Ventless Electric, Compact (240V) < 4.4 ft^3*
$Cycles_{annual}$	283	283	283	283	283
Load	8.45	8.45	3.00	3.00	3.00
$F_{elec,baseline}$	0.05	1.00	1.00	1.00	1.00
$F_{elec,ee}$	0.05	1.00	1.00	1.00	1.00
$F_{gas,baseline}$	0.95	0.00	0.00	0.00	0.00

[3] Savings calculator for ENERGY STAR® Qualified Appliances (accessed 10/18/2017)
[4] Ibid.
[5] ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] 10 CFR 430.32 (h)(3)
[10] ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017
[11] Savings calculator for ENERGY STAR® Qualified Appliances (accessed 10/18/2017)

Variable	Dryer Type				
	Vented Gas Dryer	*Ventless or Vented Electric, Standard ≥ 4.4 ft^3*	*Ventless or Vented Electric, Compact (120V) < 4.4 ft^3*	*Vented Electric, Compact (240V) < 4.4 ft^3*	*Ventless Electric, Compact (240V) < 4.4 ft^3*
$F_{gas,ee}$	0.95	0.00	0.00	0.00	0.00
$CEF_{baseline}$	3.30	3.73	3.61	3.27	2.55
CEF_{ee}	3.48	3.93	3.80	3.45	2.68
Hrs	290	290	290	290	290

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.042.[12]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a standard efficiency, residential grade clothes dryer with operating specifications as defined in the Key Variables Lookup Table above.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a residential grade clothes dryer appearing on the ENERGY STAR® qualified products list.

Operating Hours

Operating hours for residential clothes dryers are provided in the Key Variables Lookup Table above.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

A clothes dryer releases heat to the surrounding environment. Conventional vented dryers also vent air outside the building. The associated HVAC impact of dryers depends upon a number of variables including climate and placement of a dryer (i.e., in a conditioned or unconditioned space). It is an area of ongoing research.[13] These impacts are excluded from the methodology prescribed herein until they can be quantified and substantiated through independent research.

[12] Based on Central Maine Power Company "Residential End-Use Metering Project", 1988. Using 8,760 data for electric clothes dryers, calculating the CF according to the PJM peak definition. This study is not publicly available, but is referenced by the Pennsylvania Technical Reference Manual, State of Pennsylvania, 2016. http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

[13] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryers, November 2011

Ancillary Electric Savings Impacts

See Ancillary Fossil Fuel Savings Impacts section above.

References

1. ENERGY STAR® Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria Version 1.1, May 2017
   Available from:
   https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Final%20Version%201.1%20Clothes%20Dryers%20Specification%20-%20Program%20Commitment%20Criteria%20and%20Eligibility%20Criteria.pdf
2. Savings calculator for ENERGY STAR® Qualified Appliances
   Available from:
   https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx
3. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
4. Pennsylvania Technical Reference Manual, State of Pennsylvania, 2016.
   Available from:
   http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Record of Revision

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6-16-1	6/30/2016
12-17-1	12/31/2017

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REFRIGERATOR AND FREEZER RECYCLING

Measure Description

In many cases, when a refrigerator or freezer is replaced by a homeowner, the existing unit is retained, sold or donated for use elsewhere, representing additional load on the grid. This measure covers recycling of the existing, functional equipment, thereby eliminating the consumption associated with that equipment. Refrigerator and freezer recycling programs (also called "bounty" programs) receive energy savings credit for permanently removing inefficient, functional refrigerators and freezers from the electric grid.

This measure covers the recycling of primary (i.e. installed in a kitchen) and secondary (i.e. installed elsewhere) refrigerators, refrigerator-freezers and freezers. To account for the fact that secondary equipment is occasionally installed and operating for only part of the year, a part-time use adjustment factor has been applied to the annual gross savings for secondary units to establish average per unit deemed electric savings.

This measure does not cover the recycling of equipment classified by the Code of Federal Regulations as "Compact refrigerator/refrigerator-freezer/freezer". This refers to any refrigerator, refrigerator-freezer or freezer with a total refrigerated volume of less than 7.75 cubic feet (220 liters), where the total refrigerated volume has been determined in accordance with the procedure prescribed in Appendix A (refrigerators and refrigerator-freezers) or B (freezers) of 10 CFR 430 Subpart B.[1]

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

$$\Delta kW = units \times \Delta kWh/8{,}760 \times TAF \times LSAF \times CF$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
(ΔkWh/unit)	= Gross deemed annual electric savings per unit

[1] 10 CFR 430.2

TAF = Temperature Adjustment Factor
LSAF = Load Shape Adjustment Factor
CF = Coincidence Factor
8,760 = Hours in one year

Summary of Variables and Data Sources

There are several conditions that impact the estimated savings available from a refrigerator and/or freezer-recycling program. Factors such as the average type, make, model, size, and age of units recycled significantly impact the savings. Variances in these conditions have a significant impact of the level of savings that can be achieved. In addition, the average number of hours these units are plugged in and operating impact savings. Likewise, the environmental and operational conditions also impact the energy savings. These variables make establishing a projected engineering based calculation approach for per unit savings a complex task that is prone to error because of the effects of the compounding uncertainty associated with the potential variance within each of the key estimation variables. However, savings projections in this Tech Manual are based on impact evaluations completed in New York State.

The following deemed energy impact estimates shall be used in New York for refrigerator and freezer recycling programs.

Variable	Value	Notes
(ΔkWh/unit)	Primary Refrigerator – 1,218[2] Secondary Refrigerator – 794[3] Freezer - 846[4]	
TAF	1.22	Temperature Adjustment Factor; reflects load variance during summer peak due to increased ambient temperature conditions.[5]
LSAF	1.06	Load Shape Adjustment Factor; reflects the instantaneous differential from annual average load coincident with peak.[6]
CF	1.0	

Coincidence Factor (CF)

[2] Cadmus memo to Consolidated Edison, "Recommended Gross Savings Values for Refrigerator Recycling Programs", December 17, 2015
[3] Ibid.
[4] Based on Energy & Resource Solutions "Con Edison EEPS Programs - Impact Evaluation of Residential Appliance Bounty Program", May 2015. Gross unit consumption of 1,267 kWhs x part use factor of 0.685 = 846 kWhs
[5] Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study", July 29, 2004. It assumes 58% of New York homes have central air conditioning.
[6] Ibid.

The recommended value for the coincidence factor is 1.0.[7]

Baseline Efficiencies from which Savings are Calculated

The savings calculations above apply to recycling of a functioning primary[8] or secondary refrigerator, refrigerator-freezer or freezer with total refrigerated volume of 7.75 cubic feet (220 liters) or more.

Compliance Efficiency from which Incentives are Calculated

N/A

Operating Hours

Primary refrigerators or freezers are assumed to be connected to an electrical outlet 8,760 hours per year. Secondary units may only be connected part-time, but 8,760 hours per year is utilized in these cases as well for the sake of establishing conservative estimates of peak coincident demand savings.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. 10 CFR 430.2 Definitions.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
2. Cadmus memo to Consolidated Edison, "Recommended Gross Savings Values for Refrigerator Recycling Programs", December 17, 2015
3. Con Edison EEPS Programs – Impact Evaluation of Residential Appliance Bounty Program, Energy & Resource Solutions (ERS), May 4, 2015
   Available from:
   https://legacyold.coned.com/energyefficiency/PDF/ConEd_Residential_Appliance_Bounty_Program_Final_Report.pdf

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

[8] Savings can be claimed for recycling a primary refrigerator as long as savings for that replacement were not claimed by another energy efficiency program.

4. Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study", July 29, 2004
Available from:
http://www.waptac.org/data/files/website_docs/training/standardized_curricula/curricula_resources/blasnik_measurement%20and%20verification%20of%20residential%20refrigerator.pdf
5. National Renewable Energy Laboratory, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 7: Refrigerator Recycling Evaluation Protocol, April 2013.
Available from: https://www.nrel.gov/docs/fy13osti/53827.pdf

Record of Revision

Record of Revision Number	Issue Date
2	10/15/2010
7-13-4	7/31/2013
9-13-2	9/2/2013
6-15-2	6/1/2015
12-17-2	12/31/2017

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HEAT PUMP WATER HEATER (HPWH) – AIR SOURCE

Measure Description

This measure covers the installation of electric storage tank water heaters that use heat pump technology to move heat from the air (inside or outside the building) to the water storage tank and are designed to heat and store potable water at a thermostatically controlled temperature of less than 180°F. It is not intended for equipment delivering process or space heating hot water. It applies to electric heat pump water heaters with a maximum current rating of 24 amperes at a voltage no greater than 250 volts and with a rated storage tank capacity of 120 gallons or less.[1,2]

This measure applies to new construction/major renovation projects and replacement of existing electric water heaters and assumes baseline to be a minimally code compliant electric storage type water heater.

This measure applies to residential applications as well as residential-duty water heaters installed in commercial settings. In the latter case, this methodology shall be employed utilizing typical GPD values as defined in the "Gallons per Day (GPD)" section of the Commercial Storage Tank Water Heater measure detailed in this document.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left[\frac{1}{UEF_{baseline}} - \frac{1}{UEF_{ee} \times F_{derate}}\right] + \Delta kWh_{cooling} - \left(\Delta kWh_{heating} \times F_{ElecHeat}\right)$$

$$\Delta kWh_{cooling} = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left[1 - \frac{1}{UEF_{ee}}\right] \times F_{Loc} \times \frac{F_{Cool}}{SEER/3.412}$$

$$\Delta kWh_{heating} = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left[1 - \frac{1}{UEF_{ee}}\right] \times F_{Loc} \times \frac{F_{Heat}}{HSPF/3.412}$$

Peak Coincident Demand Savings

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

[1] ENERGY STAR® Program Requirements Product Specification for Residential Water Heaters, Eligibility Criteria Version 3.2, September 2017
[2] 10 CFR 430.2

Annual Gas Energy Savings

$$\Delta therms = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left[1 - \frac{1}{UEF_{ee}}\right] \times F_{Loc} \times F_{GasHeat} \times \frac{F_{Heat}}{AFUE}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
GPD	= Gallons per day
ΔT_{main}	= Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure
UEF	= Uniform energy factor
F_{derate}	= Efficiency derating factor used to account for the degradation of heat pump performance present in systems installed in unconditioned spaces
$\Delta kWh_{cooling}$	= Annual electric cooling energy savings as a result of interactivity with the building's HVAC system (electric cooling bonus)
$\Delta kWh_{heating}$	= Annual electric heating energy savings as a result of interactivity with the building's HVAC system (electric heating penalty)
$F_{ElecHeat}$	= Electric heating factor, used to exclude electric heating penalty if no electric heating is present
F_{Loc}	= Installation location factor, used to exclude interactive HVAC impacts for systems installed in unconditioned spaces
F_{Cool}	= Cooling factor, used to account for the percentage of heat extracted from ambient air by the heat pump water heater that reduces space cooling load
SEER	= Seasonal average energy efficiency ratio over the cooling season, BTU/watthour, (used for average U.S. location/region)
F_{Heat}	= Heating factor, used to account for the percentage of heat extracted from ambient air by the heat pump water heater that increases space heating load
HSPF	= Heating seasonal performance factor, BTU/watt-hour, total heating output (supply heat) in BTU (including electric heat) during the heating season / total electric energy heat pump consumed (in watt-hour)
$F_{GasHeat}$	= Gas heating factor, used to exclude gas heating penalty if no gas heating is present
AFUE	= Annual fuel utilization efficiency, seasonal energy efficiency for fuel heating equipment
(ΔkW/unit)	= Deemed peak coincident demand savings per measure
365	= Days in one year
8.33	= Energy required (BTU) to heat one gallon of water by one degree Fahrenheit
3,412	= Conversion factor, one kWh equals 3,412 BTU

3.412 = Conversion factor, one watt-hour equals 3.412142 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
GPD	17.2 X # of people	Calculated based on number of people served by the system. If unknown, use 46 GPD.[3]
ΔT_{main}	T_{set} - T_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F).
T_{set}	140	Water heater set point temperature (°F).[4]
T_{main}		Supply water temperature in water main (°F). Lookup in Cold Water Inlet Temperature table below based on nearest city.
$UEF_{baseline}$		Uniform Energy Factor of the baseline condition. See Baseline Efficiencies… section below for details regarding derivation of this input.
UEF_{ee}		Uniform Energy Factor of the energy efficient measure, from application.
F_{derate}		For equipment installed in unconditioned spaces, lookup in Derate Factor table below based on installation location and nearest city. For equipment installed in conditioned spaces, a value of 1.0 shall be used.
$F_{ElecHeat}$		Use a value of 1.0 if the building is electrically heated. Otherwise, use 0.0.
F_{Loc}		Use a value of 1.0 if the water heater is installed in a conditioned space. Otherwise, use 0.0.
F_{Cool}		Lookup in HVAC Interactivity table below based on nearest city.
SEER	13	Assumed efficiency of existing air conditioning system, based on a minimally code compliant, 3-ton, split system AC.[5]
F_{Heat}		Lookup in HVAC Interactivity table below based on nearest city.
HSPF	Heat Pump – 8.2 Electric Resistance – 3.412	Assumed efficiency of electric heating system, based on a COP of 1.0 for electric resistance heating and a minimally code compliant, 3-ton split system HP for heat pumps.[6]
$F_{GasHeat}$		Use a value of 1.0 if the building is gas heated. Otherwise, use 0.0.

[3] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household.
[4] Per OSHA recommendations for prevention of Legionalla bacterial growth (https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html)
[5] ECCCNYS 2016, Table C403.2.3(1) & NYCECC 2016, Table C403.2.3(1)
[6] ECCCNYS 2016, Table C403.2.3(2) & NYCECC 2016, Table C403.2.3(2)

Variable	Value	Notes
AFUE	80%	Assumed efficiency of gas heating system, based on a minimally code compliant, 80 MBH gas furnace.[7]
(ΔkW/unit)	0.17	Deemed peak coincident demand savings[8]

Cold Water Inlet Temperature (T_{main})

Supply water main temperatures vary according to climate, and are approximately equal to the annual average outdoor temperature plus 6°F.[9] Supply main temperatures based on the annual outdoor temperature are shown below.

City	Annual average outdoor temperature[10] (°F)	T_{main} (°F)
Albany	48.3	54.3
Binghamton	46.3	52.3
Buffalo	48.3	54.3
Massena	43.5	49.5
NYC	55.4	61.4
Poughkeepsie	49.8	55.8
Syracuse	48.3	54.3

Derate Factor

Standard testing conditions for rating of heat pump water heaters require a dry bulb temperature of 67.5°F ± 1°F and a relative humidity of 50% ±2%.[11] The reported efficiency of heat pump water heaters is established at these conditions; however, heat pump efficiency degrades at lower ambient temperatures. The Derate Factor is established to adjust the published efficiency of the qualifying heat pump water heater when the system is installed in semi-conditioned or unconditioned spaces, namely, garages and basements. The values shown below were derived from Table 10 of Residential Heat Pump Water Heater Evaluation: Lab Testing & Energy Use Estimates published by Bonneville Power Administration in 2011[12] and verified via comparison with results from the 2013 NEEA Heat Pump Water Heater Field Study Report.[13] Average values from northwest heating zones 1 (<6,000 HDD), 2 (6,000 – 7,500 HDD) and 3 (>7,500 HDD)[14] from this analysis and comparison were then mapped to representative NY climate regions as shown below.

[7] 10 CFR 430.32 (e) (2) (i) (A)
[8] "Field Testing of Pre-Production Prototype Heat Pump Water Heaters" Federal Energy Management Program, DOE/EE-0317, May 2007.
[9] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory
[10] Average annual outdoor temperatures taken from NCDC 1981-2010 climate normals
[11] 10 CFR 430 Subpart B Appendix E
[12] Residential Heat Pump Water Heater Evaluation: Lab Testing & Energy Use Estimates, Bonneville Power Administration, November 2011
[13] NEEA Heat Pump Water Heater Field Study Report, Fluid Market Strategies, October 2013
[14] NW Council Heating/Cooling zone maps

City	F_{derate} (Unconditioned Basement Installation)	F_{derate} (Garage Installation)
Albany	0.80	0.78
Binghamton	0.80	0.78
Buffalo	0.80	0.78
Massena	0.75	0.69
NYC	0.86	0.83
Poughkeepsie	0.80	0.78
Syracuse	0.80	0.78

HVAC Interactivity

Because heat pump water heaters operate via the transfer of heat from the ambient air to the water in the storage tank, systems installed in conditioned spaces will interact with the building's HVAC system. The values shown in the table below reflect the percentage of heat extracted from the ambient air by the heat pump that either decreases the building's cooling load (F_{Cool}) or increases the building's heating load (F_{Heat}). These values were derived from Table 12 of Residential Heat Pump Water Heater Evaluation: Lab Testing & Energy Use Estimates published by Bonneville Power Administration in 2011[15] and key operating assumptions specified therein. Average values from northwest heating zones 1 (<6,000 HDD), 2 (6,000 – 7,500 HDD) and 3 (>7,500 HDD)[16] were then mapped to representative NY climate regions and scaled linearly based on regional HDD and CDD. The HDD and CDD values are based on 30-year averages of U.S annual climate normals between 1981 and 2010 using base 65° F.[17]

City	CDD	F_{Cool}	HDD	F_{Heat}
Albany	597	0.26	6680	0.70
Binghamton	382	0.17	7193	0.76
Buffalo	544	0.24	6617	0.70
Massena	363	0.16	8196	0.84
Poughkeepsie	671	0.29	6210	0.65
NYC	1160	0.51	4671	0.49
Syracuse	570	0.25	6651	0.70

Coincidence Factor (CF)

The recommended value for the coincidence factor is N/A. Deemed demand savings values incorporate system peak coincidence considerations.

Baseline Efficiencies from which Savings are Calculated

[15] Residential Heat Pump Water Heater Evaluation: Lab Testing & Energy Use Estimates, Bonneville Power Administration, November 2011

[16] NW Council Heating/Cooling zone maps

[17] HDD/CDD taken from NCDC 1981-2010 climate normals

The baseline condition is a minimally code compliant electric storage water heater with storage tank capacity and draw pattern equivalent to the proposed case.
$UEF_{baseline}$ shall be calculated as a function of qualifying equipment tank volume (v_t) per federal standards[18] as shown in the table below, using the qualifying equipment capacity and draw pattern. Draw pattern can be established based on the proposed equipment First Hour Rating (FHR), rated in gallons. See First Hour Rating vs. Draw Pattern table below. If FHR is unknown, a Medium draw pattern should be assumed for equipment with rated storage capacity ≤50 gallons and a High draw pattern should be assumed otherwise.[19]

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	$UEF_{baseline}$
Electric Storage Water Heater	≥ 20 gal and ≤ 55 gal	Very Small	0.8808 - (0.0008 x v_t)
		Low	0.9254 - (0.0003 x v_t)
		Medium	0.9307 - (0.0002 x v_t)
		High	0.9349 - (0.0001 x v_t)
	> 55 gal and ≤ 120 gal	Very Small	1.9236 - (0.0011 x v_t)
		Low	2.0440 - (0.0011 x v_t)
		Medium	2.1171 - (0.0011 x v_t)
		High	2.2418 - (0.0011 x v_t)

*v_t = tank volume in gallons

First Hour Rating vs. Draw Pattern[20]

First Hour Rating	Draw Pattern
<18 gallons	Very Small
≥18 and <51 gallons	Low
≥51 and <75 gallons	Medium
≥75 gallons	High

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a heat pump water heater meeting minimum performance requirements dictated by program eligibility criteria.

Operating Hours

Water heater run hours are not utilized in the estimation of energy or demand savings, but water heater is assumed to be available for operation 8,760 hours per year.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

[18] 10 CFR 430.32(d)
[19] Based on review of typical usage bins for AHRI certified residential water heating equipment (https://www.ahridirectory.org/ahridirectory/pages/home.aspx)
[20] 10 CFR 429.17

Heat pump water heaters installed in conditioned spaces will result in an increase in space heating load due to the extraction of heat from the ambient air. This interactivity is addressed in the prescribed methodology.

Ancillary Electric Savings Impacts

Heat pump water heaters installed in conditioned spaces will result in an increase in space heating load and a decrease in cooling load due to the extraction of heat from the ambient air. This interactivity is addressed in the prescribed methodology.

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0	10/15/2010
6-13-3	6/30/2013
11-13-2	11/26/2013
12-17-3	12/31/2017

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INDIRECT WATER HEATER

Measure Description

This measure covers the installation of a gas indirect-fired storage water heating system in which the stored water is heated via hot water produced by a gas boiler rather than direct input from electric elements or gas burners. In such a system, a heat exchanger separates the potable water in the water heater from the boiler water. This measure applies to indirect-fired systems comprising a boiler with input heating capacity less than 300,000 Btu/h and a storage tank with a capacity of 20 to 120 gallons. Larger equipment installed in whole building or multi-unit multifamily settings shall use the Commercial and Industrial Indirect Water Heater measure detailed in this document.

This measure estimates savings associated with the delivery of potable hot water only and assumes the installation of zone priority controls to interrupt demand for space heating hot water until domestic hot water demand is met.

This measure assumes baseline to be a minimally code compliant gas storage type water heater with storage capacity equivalent to the proposed case.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

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

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
GPD	= Gallons per day
ΔT_{main}	= Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	= Average temperature difference between water heater set point temperature and

the surrounding ambient air temperature (°F)
baseline = Baseline condition or measure
ee = Energy efficient condition or measure
Eff = Efficiency
UA = Overall heat loss coefficient (BTU/hr-°F)
365 = Days in one year
8.33 = Energy required (BTU) to heat one gallon of water by one degree Fahrenheit
100,000 = Conversion factor (BTU/therm), one therm equals 100,000 BTU
8,760 = Hours in one year

Summary of Variables and Data Sources

Variable	Value	Notes
GPD	17.2 X # of people	Calculated based on number of people served by the system. If unknown, use 46 GPD.[1]
ΔT_{main}	T_{set} - T_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	70 (T_{set} - T_{amb})	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
T_{set}	140	Water heater set point temperature (°F).[2]
T_{main}		Supply water temperature in water main (°F). Lookup in Cold Water Inlet Temperature table below based on nearest city.
T_{amb}	70	Surrounding ambient air temperature (°F).[3]
$Eff_{baseline}$	75%	Efficiency of the baseline condition.[4]
Eff_{ee}		Efficiency of energy efficient indirect-system boiler (AFUE), from application.
$UA_{baseline}$	7.85	Overall heat loss coefficient of the baseline condition (BTU/hr-°F).[5]

[1] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household.
[2] Per OSHA recommendations for prevention of Legionalla bacterial growth (https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html)
[3] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.
[4] Per 10 CFR 430, typical recovery efficiency of a gas water heater, which is used for the purposes of this measure as a proxy for thermal efficiency, is 0.75. See for example, 10 CFR 430 Subpart B Appendix C1, 5.6.1.1.
[5] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was equated for two minimally code compliant gas storage water heaters found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 Btu/h assumed) and between 55 and 120 gallon capacity (75 gallon, 76,000 Btu/h assumed). Results of heat loss coefficient evaluation at these two data points agreed to within 0.3%, so the lower of the two was selected to represent the $UA_{baseline}$ term.

Variable	Value	Notes
UA_{ee}		Overall heat loss coefficient of the energy efficient measure (BTU/hr-°F). Calculate per Qualifying Heat Loss Coefficient section below, based on qualifying equipment standby loss specification, rated in °F/hr. If unknown, assume UA_{ee} = 5.4.[6]

Cold Water Inlet Temperature (T_{main})

Supply water main temperatures vary according to climate, and are approximately equal to the annual average outdoor temperature plus 6°F.[7] Supply main temperatures based on the annual outdoor temperature are shown below.

City	Annual average outdoor temperature[8] (°F)	T_{main} (°F)
Albany	48.3	54.3
Binghamton	46.3	52.3
Buffalo	48.3	54.3
Massena	43.5	49.5
NYC	55.4	61.4
Poughkeepsie	49.8	55.8
Syracuse	48.3	54.3

Qualifying Heat Loss Coefficient (UA_{ee})

Indirect-fired water heater storage tanks are tested and rated for standby losses (in °F/hr) at standard testing conditions in accordance with testing standards.[9] The qualifying equipment standby loss specification (SL_{ee}), where available, shall be used in the formula below, along with tank volume (v_{ee}) to establish the qualifying equipment heat loss coefficient (UA_{ee}).

$$UA_{ee} = \frac{SL_{ee}}{70} \times v_{ee} \times 8.33$$

where:

UA_{ee} = Overall heat loss coefficient (BTU/hr-°F) of the energy efficient condition or measure

SL_{ee} = Standby loss specification (°F/hr) of the energy efficient condition or measure

v_{ee} = Rated storage capacity (gallons) of the energy efficient condition or measure

70 = Temperature differential (°F) utilized in standby loss testing procedure

8.33 = Energy required (BTU) to heat one gallon of water by one degree Fahrenheit

[6] Based on the average standby loss specification (in °F/hr) of AHRI-certified Indirect Water Heater storage tanks, per the AHRI Directory.

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

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

[9] GAMA Testing Standard: Performance of Indirect-Fired Water Heaters, March 2003

Coincidence Factor (CF)

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

Baseline Efficiencies from which Incentives are Calculated

The baseline condition is a minimally code compliant gas storage type water heater with a recovery efficiency of 75%, tank volume equal to the energy efficient condition and heat loss coefficient as indicated above.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an indirect gas-fired water heating system meeting minimum performance requirements dictated by program eligibility criteria.

Operating Hours

Water heater run hours are not utilized in the estimation of energy or demand savings, but water heater is assumed to be available for operation 8,760 hours per year. Additionally, it is assumed standby losses are incurred 8,760 hours per year.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in standby heat losses will have a negligible impact on space heating when the water heater is located in conditioned space. Consideration of these effects is not included in this methodology.

Ancillary Electric Savings Impacts

Reduction in standby heat losses will have a negligible impact on space heating and cooling when the water heater is located in conditioned space. Consideration of these effects is not included in this methodology.

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7-13-6	7/31/2013
7-13-29	7/31/2013
7-13-33	7/31/2013
7-13-34	7/31/2013
7-13-35	7/31/2013
11-13-2	11/26/2013
12-17-4	12/31/2017

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STORAGE TANK AND INSTANTANEOUS DOMESTIC WATER HEATER

Measure Description

This measure covers the installation of storage tank water heaters designed to heat and store water at a thermostatically controlled temperature, as well as instantaneous type water heaters, which heat water but contain no more than one gallon of water per 4,000 BTU per hour of input. This measure applies to potable hot water delivery only; it is not applicable to hot water heaters used for process loads or space heating. Additionally, qualifying equipment must be designed to heat water to a temperature no greater than 180°F and, if electric power is required for operation, must use a single-phase external power supply.

Storage type units include residential gas storage water heaters with a nominal input of 75,000 BTU per hour or less and a rated storage capacity between 20 and 100 gallons, residential-duty commercial gas storage water heaters with a nominal input of greater than 75,000 BTU per hour and less than or equal to 105,000 BTU per hour and a rated storage capacity between 20 and 120 gallons and electric storage water heaters with an input of 12 kilowatts or less and a rated storage capacity between 20 and 120 gallons.

Instantaneous type units include gas instantaneous water heaters with a rated input capacity of greater than or equal to 50,000 and less than 200,000 BTU per hour and a manufacturer's specified storage capacity of less than 2 gallons, residential electric instantaneous water heaters with an input of 12 kilowatts or less and a manufacturer's specified storage capacity of less than 2 gallons and residential-duty commercial electric instantaneous water heaters with an input of greater than 12 kilowatts and less than or equal to 56.8 kilowatts and a manufacturer's specified storage capacity of 2 gallons or less.[1]

This measure applies to replacement of existing storage type and instantaneous water heaters using the same heating fuel (gas or electric) as the proposed case. For new construction, this measure assumes baseline to be a minimally code compliant water heater of the same type (storage or instantaneous) and using the same heating fuel (gas or electric) as the proposed case.

This measure applies to residential applications as well as residential-duty water heaters installed in commercial settings. In the latter case, this methodology shall be employed utilizing typical GPD values as defined in the "Gallons per Day (GPD)" section of the Commercial Storage Tank Water Heater measure detailed in this document.

[1] Definitions of qualifying system types and specifications per 10 CFR 430.2 and revised in accordance with the limitations imposed by 10 CFR 430.32(d) and 10 CFR 431.110(b).

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings (Electric Equipment Only)

$$\Delta kWh = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left[\frac{1}{UEF_{baseline}} - \frac{1}{UEF_{ee}}\right]$$

Peak Coincident Demand Savings (Electric Equipment Only)

$$\Delta kW = units \times \frac{(UA_{baseline} - UA_{ee}) \times \Delta T_{amb}}{3{,}412} \times CF$$

Annual Gas Energy Savings (Gas Equipment Only)

$$\Delta therms = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left[\frac{1}{UEF_{baseline}} - \frac{1}{UEF_{ee}}\right]$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
GPD	= Gallons per day
ΔT_{main}	= Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	= Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure

UEF = Uniform energy factor

UA = Overall heat loss coefficient (BTU/hr-°F)

CF = Coincidence factor

365 = Days in one year

8.33 = Energy required (BTU) to heat one gallon of water by one degree Fahrenheit

3,412 = Conversion factor, one kWh equals 3,412 BTU

100,000 = Conversion factor (BTU/therm), one therm equals 100,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
GPD	17.2 X # of people	Calculated based on number of people served by the system. If unknown, use 46 GPD.[2]
ΔT_{main}	T_{set} - T_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	70 (T_{set} - T_{amb})	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
T_{set}	140	Water heater set point temperature (°F).[3]
T_{main}		Supply water temperature in water main (°F). Lookup in Cold Water Inlet Temperature table below based on nearest city.
T_{amb}	70	Surrounding ambient air temperature (°F).[4]
$UEF_{baseline}$		Uniform Energy Factor of the baseline condition. See Baseline Efficiencies… section below for details regarding derivation of this input.

[2] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household.
[3] Per OSHA recommendations for prevention of Legionalla bacterial growth (https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html)
[4] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.

Variable	Value	Notes
UEF_{ee}		Uniform Energy Factor of the energy efficient measure, from application
$UA_{baseline}$	7.85	Overall heat loss coefficient of the baseline condition (BTU/hr-°F).[5]
UA_{ee}		Overall heat loss coefficient of the energy efficient measure (BTU/hr-°F). For instantaneous water heaters, set $UA_{ee} = 0$. For storage type water heaters, set $UA_{ee} = 5.4$.[6]
CF	0.8	

[5] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was equated for two minimally code compliant gas storage water heaters found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 Btu/h assumed) and between 55 and 120 gallon capacity (75 gallon, 76,000 Btu/h assumed). Results of heat loss coefficient evaluation at these two data points agreed to within 0.3%, so the lower of the two was selected to represent the $UA_{baseline}$ term.

[6] Based on the average standby loss specification (in °F/hr) of AHRI-certified Indirect Water Heater storage tanks, per the AHRI Directory.

Cold Water Inlet Temperature (T_{main})

Supply water main temperatures vary according to climate, and are approximately equal to the annual average outdoor temperature plus 6°F.[7] Supply main temperatures based on the annual outdoor temperature are shown below.

City	Annual average outdoor temperature[8] (°F)	T_{main} (°F)
Albany	48.3	54.3
Binghamton	46.3	52.3
Buffalo	48.3	54.3
Massena	43.5	49.5
NYC	55.4	61.4
Poughkeepsie	49.8	55.8
Syracuse	48.3	54.3

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8[9].

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a minimally code compliant gas or electric storage or instantaneous type water heater (based on proposed conditions) with tank volume, input capacity and draw pattern equivalent to the proposed case.

$UEF_{baseline}$ shall be calculated as a function of qualifying equipment tank volume (v_t) for storage type water heaters or looked up for instantaneous water heaters per federal standards from the appropriate table (Residential Water Heaters or Residential-Duty Commercial Water Heaters) below, using the qualifying equipment type, capacity and draw pattern. Draw pattern can be established based on the proposed equipment First Hour Rating (FHR), rated in gallons, for storage type water heaters or Max Gallons per Minute (GPM), rated in gallons/minute, for

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

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

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

instantaneous water heaters. See the First Hour Rating vs. Draw Pattern and Max GPM vs. Draw Pattern tables below for storage type and instantaneous water heaters, respectively. If FHR or Max GPM is unknown, a Medium draw pattern should be assumed for storage type water heaters with rated storage capacity ≤50 gallons and a High draw pattern should be assumed otherwise.[10]

[10] Based on review of typical usage bins for AHRI certified residential water heating equipment (https://www.ahridirectory.org/ahridirectory/pages/home.aspx)

Residential Water Heaters[11]

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	$UEF_{baseline}$
Gas-Fired Storage Water Heater	≥ 20 gal and ≤ 55 gal	Very Small	$0.3456 - (0.0020 \times V_t^*)$
		Low	$0.5982 - (0.0019 \times V_t)$
		Medium	$0.6483 - (0.0017 \times V_t)$
		High	$0.6920 - (0.0013 \times V_t)$
	> 55 gal and ≤ 100 gal	Very Small	$0.6470 - (0.0006 \times V_t)$
		Low	$0.7689 - (0.0005 \times V_t)$
		Medium	$0.7897 - (0.0004 \times V_t)$
		High	$0.8072 - (0.0003 \times V_t)$
Electric Storage Water Heater	≥ 20 gal and ≤ 55 gal	Very Small	$0.8808 - (0.0008 \times V_t)$
		Low	$0.9254 - (0.0003 \times V_t)$
		Medium	$0.9307 - (0.0002 \times V_t)$
		High	$0.9349 - (0.0001 \times V_t)$
	> 55 gal and ≤ 120 gal	Very Small	$1.9236 - (0.0011 \times V_t)$
		Low	$2.0440 - (0.0011 \times V_t)$
		Medium	$2.1171 - (0.0011 \times V_t)$
		High	$2.2418 - (0.0011 \times V_t)$
Instantaneous Gas-Fired Water Heater	< 2 gal and > 50,000 Btu/h	Very Small	0.80
		Low	0.81
		Medium	0.81
		High	0.81
Instantaneous Electric Water Heater	< 2 gal	Very Small	0.91
		Low	0.91
		Medium	0.91
		High	0.92

[11] 10 CFR 430.32(d)

*v_t = tank volume in gallons

Residential-Duty Commercial Water Heaters[12]

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	$UEF_{baseline}$
Gas-Fired Storage Water Heater	> 75,000 Btu/h and ≤ 105,000 Btu/h and ≤ 120 gal	Very Small	0.2674 - (0.0009 x v_t*)
		Low	0.5362 - (0.0012 x v_t)
		Medium	0.6002 - (0.0011 x v_t)
		High	0.6597 - (0.0009 x v_t)
Instantaneous Electric Water Heater	> 12 kW gal and ≤ 55 gal	Very Small	0.80
		Low	0.80
		Medium	0.80
		High	0.80

*v_t = tank volume in gallons

First Hour Rating vs. Draw Pattern (Storage Type Only)[13]

First Hour Rating	Draw Pattern
< 18 gallons	Very Small
≥ 18 and < 51 gallons	Low
≥ 51 and < 75 gallons	Medium
≥ 75 gallons	High

[12] 10 CFR 431.110(b)
[13] 10 CFR 429.17

Max GPM vs. Draw Pattern (Instantaneous Only)[14]

Max GPM	Draw Pattern
< 1.7 gallons/minute	Very Small
≥ 1.7 and < 2.8 gallons/minute	Low
≥ 2.8 and < 4.0 gallons/minute	Medium
≥ 4.0 gallons/minute	High

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a gas or electric storage or instantaneous type water heater as defined in the Measure Description section above meeting minimum performance requirements dictated by program eligibility criteria.

Operating Hours

Water heater run hours are not utilized in the estimation of energy or demand savings, but water heater is assumed to be available for operation 8,760 hours per year. Additionally, it is assumed standby losses are incurred 8,760 hours per year.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in standby heat losses will have a negligible impact on space heating when the water heater is located in conditioned space. Consideration of these effects is not included in this methodology.

Ancillary Electric Savings Impacts

Reduction in standby heat losses will have a negligible impact on space heating and cooling when the water heater is located in conditioned space. Consideration of these effects is not included in this methodology.

[14] 10 CFR 429.17

References

1. 10 CFR 430.2 Definitions.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
2. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
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   Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=9624a8ba0987aaae248454c49194a661&mc=true&n=pt10.3.430&r=PART&ty=HTML#ap10.3.430_127.e
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   https://energy.gov/sites/prod/files/2016/08/f33/Water%20Heaters%20Test%20Procedure%20SNOPR.pdf
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9. Burch, Jay and Craig Christensen; "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory.
   Available from:
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10. NOAA National Centers for Environmental Information – NCDC 1981-2010 Climate Normals
    Available from: https://www.ncdc.noaa.gov/cdo-web/datatools/normals
11. 10 CFR 429.17 Water heaters.

Available from: https://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=10:3.0.1.4.17#se10.3.429_117

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
6-13-1	6/30/2013
7-13-6	7/31/2013
11-13-2	11/26/2013
12-17-5	12/31/2017

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

AIR CONDITIONER - CENTRAL (CAC)

Measure Description

This measure covers the installation of high-efficiency central air conditioners in residential applications. A central air conditioner is a product, other than a packaged terminal air conditioner, which is powered by single phase electric current, air cooled, rated below 65,000 Btu per hour, not contained within the same cabinet as a furnace with rated capacity above 225,000 Btu per hour, and is a
cooling unit only. A central air conditioner may consist of a single-package unit or an outdoor unit and one or more indoor units, including multi-head mini-split systems.[1] The baseline case shall be minimally code compliant equipment of the same type and capacity as in the proposed case, which shall be sized in accordance with federal, state and local energy conservation code.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times tons/unit \times \left(\frac{12}{SEER_{baseline}} - \frac{12}{SEER_{ee}}\right) \times EFLH_{cooling}$$

Peak Coincident Demand Savings

$$\Delta kW = units \times tons/unit \times \left(\frac{12}{EER_{baseline}} - \frac{12}{EER_{ee}}\right) \times CF$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
tons/unit	= Tons of air conditioning per unit, based on AHRI certification or nameplate data of condenser or matched pair (condenser and coil)
ee	= Energy efficient condition or measure
baseline	= Baseline condition or measure
SEER	= Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
EFLH	= Equivalent full-load hours

[1] 10 CFR 430.2

EER = Energy efficiency ratio under peak conditions
CF = Coincidence factor
12 = kBTUh/ton of air conditioning capacity

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application, default to average system size from applications if unknown
$SEER_{baseline}$		Lookup from Baseline Efficiencies table below based on product class and size.
$SEER_{ee}$		From application
$EFLH_{cooling}$		Lookup based on building type, vintage and location from Appendix G.
$EER_{baseline}$		Lookup from Baseline Efficiencies table below based on product class and size.
EER_{ee}		From application
CF	0.69	

Coincidence Factor (CF)

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

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a central air conditioner as defined in the Measure Description section above, with rated SEER and EER per the table below. The SEER values listed in the table below reflect the minimum performance required by federal standards. Minimum EER requirements are not specified by federal standards for the state of New York, nor are they mandated by state or city code for residential equipment. For this equipment, baseline EER is established as follows[3]:

$$EER = (1.12 \times SEER) - (0.02 \times SEER^2)$$

Resultant values from application of this equation are tabulated in the baseline efficiencies table below.

[2] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by the Mid-Atlantic TRM Version 7.0 published May 2017 and by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011 and supported by research conducted by Cadmus on behalf of the TRM Management Committee.
[3] DOE, Building America House Simulation Protocols, October 2010

Product Class	Seasonal Energy Efficiency Ratio (SEER)[4]	Energy Efficiency Ratio (EER)
Split System – Air Conditioner (<45 kBTUh)	13.0	11.2
Split System – Air Conditioner (≥45 and <65 kBTUh)	13.0	11.2
Single Package – Air Conditioner	14.0	11.8

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a central air conditioner as defined in the Measure Description section above meeting minimum performance requirements dictated by program guidelines.

Operating Hours

Cooling EFLH data by location, building type and vintage are tabulated in Appendix G.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Minor heating interactions are expected with efficient furnace fans utilized in most high efficiency air conditioners. These impacts are expected to be negligible and have not been addressed in the prescribed methodology at this time.

Ancillary Electric Savings Impacts

N/A

References

1. 10 CFR 430.2 Definitions.
   Available from:
   http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
2. BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps, via Mid-Atlantic Technical Reference Manual Version 7.0, May 2017 (accessed October 26, 2017)
   Available from:
   http://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V7_FINAL.pdf
3. M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011
   Available from: https://www.sciencedirect.com/science/article/pii/S1040619011001941

[4] 10 CFR 430.32 (c)(1)

4. Building America House Simulation Protocols, Robert Hendron and Cheryn Engebrecht, National Renewable Energy Laboratory, October 2010
   Available from: https://www.nrel.gov/docs/fy11osti/49246.pdf
5. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
12-17-6	12/31/2017

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BLOWER FAN – WITH ELECTRONICALLY COMMUTATED (EC) MOTOR FOR FURNACE DISTRIBUTION

Measure Description

This measure covers the retrofit of direct-drive Permanent Split Capacitor (PSC) motors with the installation of Electronically Commutated (EC) motors on gas furnace distribution system supply fans in residential applications. Energy savings are realized through reductions in fan power due to improved motor efficiency.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of motors installed under the program
(ΔkWh/unit)	= Annual electric savings per motor installed
(ΔkW/unit)	= Electric demand savings per motor installed
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
(ΔkWh/unit)		Lookup based on location and HVAC system type in table below.[1]
(ΔkW/unit)	0.117	Derived from Focus on Energy evaluation.[2]
CF	0.680	

[1] Cadmus Group, Focus on Energy Evaluated Deemed Savings Changes, November 2014
[2] Ibid.

The deemed annual electric energy savings are determined for each New York location by scaling the energy savings derived from the evaluation of a 2014 Wisconsin ECM metering study using heating degree days and cooling degree days for each location.[3] The Wisconsin study metered furnaces in 67 homes in Wisconsin in 2012 and 2013.

The total energy savings for each New York location are provided in the "Total" columns below. The energy savings are determined by summing the savings attributed to each furnace mode: circulation, heating and cooling. Homes with a central A/C receive the savings in the "Total (with Central A/C)" column. Homes without a central A/C receive the savings in the "Total (without Central A/C)": these savings exclude the "Cooling Mode" savings. The HDD and CDD values are based on 30-year averages of U.S annual climate normals between 1981 and 2010 using base 65° F.[4]

City	Annual Energy Saved (ΔkWh/unit)					HDD	CDD
	Total (with Central A/C)	Total (without Central A/C)	Circulation Mode	Heating Mode	Cooling Mode		
Albany	404	333	211	122	71	6,680	597
Binghamton	388	342	211	131	46	7,193	382
Buffalo	397	332	211	121	65	6,617	544
Massena	404	361	211	150	43	8,196	363
Poughkeepsie	404	324	211	113	80	6,210	671
NYC	435	296	211	85	139	4,671	1,160
Syracuse	401	333	211	122	68	6,651	570

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.680.[5]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a residential furnace (with or without central AC) with a direct-drive PSC distribution system blower motor.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a residential furnace (with or without central AC) with an EC distribution system blower motor.

[3] The percent difference in HDD is applied to the Heating Mode column kWh savings and the percent difference in the CDD is applied to the Cooling Mode column kWh savings.
[4] Annual/Seasonal Normals taken from http://www.ncdc.noaa.gov/cdo-web/datatools/normals
[5] Cadmus Group, Focus on Energy Evaluated Deemed Savings Changes, November 2014

Operating Hours

While deemed savings are associated with operating hours, savings values are established based on a comparison of heating and cooling degree days for various locations in NY state and Wisconsin. As such, operating hours are not directly applied in the methodology prescribed for this measure, though they are embedded in the derivation of deemed savings. Circulation mode savings and by association, operating hours, are assumed to align with findings of the Wisconsin ECM metering study. Thus, savings associated with circulation-only mode are equivalent across all climate zones.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. Cadmus Group, Inc., Focus on Energy Evaluated Deemed Savings Changes, prepared for The Public Service Commission of Wisconsin, November 14, 2014
   Available from:
   https://focusonenergy.com/sites/default/files/FoE_Deemed_WriteUp%20CY14%20Final.pdf
2. Cadmus Group, Inc., June 4, 2014 ECM Metering Results Memo. Delivered to Carol Stemrich, PSC of Wisconsin.
3. NOAA National Centers for Environmental Information – 1981-2010 Normals.
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Record of Revision

Record of Revision Number	Issue Date
0	10/15/2010
1	3/31/2016
6-16-2	6/30/2016
12-17-7	12/31/2017

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HEAT PUMP - AIR SOURCE (ASHP)

Measure Description

This measure covers the installation of high-efficiency air source heat pumps in residential applications. An air source heat pump is a product, other than a packaged terminal heat pump, which is powered by single phase electric current, air cooled, rated below 65,000 Btu per hour, not contained within the same cabinet as a furnace with rated capacity above 225,000 Btu per hour, and operates as a heat pump. An air source heat pump may consist of a single-package unit or an outdoor unit and one or more indoor units, including multi-head mini-split systems.[1] The baseline case shall be minimally code compliant equipment of the same type and capacity as in the proposed case, which shall be sized in accordance with federal, state and local energy conservation code. Baseline and proposed equipment is assumed to include electric resistance supplemental heating of the same capacity. Thus, although rated capacity and efficiencies used in this measure incorporate supplemental heating elements, no savings are attributed to reduction in electric resistance heating capacity.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = units \times tons/unit \times \left(\frac{12}{SEER_{baseline}} - \frac{12}{SEER_{ee}}\right) \times EFLH_{cooling}$$

$$\Delta kWh_{heating} = units \times \frac{kBTUh_{out}}{unit} \times \left(\frac{1}{HSPF_{baseline}} - \frac{1}{HSPF_{ee}}\right) \times EFLH_{heating} \frac{kBTUh_{out}}{unit} \times \left(\frac{1}{HSPF_{baseline}} - \frac{1}{HSPF_{ee}}\right) \times EFLH_{heating}$$

Peak Coincident Demand Electric Savings

$$\Delta kW = units \times tons/unit \times \left(\frac{12}{EER_{baseline}} - \frac{12}{EER_{ee}}\right) \times CF$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings

[1] 10 CFR 430.2

units = Number of units installed under the program
tons/unit = Tons of air conditioning per unit, based on AHRI certification or nameplate data of condenser or matched pair (condenser and coil)
$kBTUh_{out}$/unit = The nominal rating of the heating output capacity of the heat pump in kBTU/hr (including supplemental heaters) per unit, based on AHRI certification or nameplate data of condenser or matched pair (condenser and coil)
$_{ee}$ = Energy efficient condition or measure
$_{baseline}$ = Baseline condition or measure
HSPF = Heating seasonal performance factor, BTU/watt-hour, total heating output (supply heat) in BTU (including supplemental heaters) during the heating season / total electric energy heat pump consumed (in watt-hour)
SEER = Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, used for average U.S. location/region
EER = Energy efficiency ratio under peak conditions
EFLH = Equivalent full-load hours
CF = Coincidence factor
12 = kBTUh/ton of air conditioning capacity

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application, default to average system size from applications if unknown
$kBTUh_{out}$		From application
$SEER_{baseline}$		Lookup from Baseline Efficiencies table below based on product class and size.
$SEER_{ee}$		From application
$EFLH_{cooling}$		Lookup based on building type, vintage and location from Appendix G.
$HSPF_{baseline}$		Lookup from Baseline Efficiencies table below based on product class and size.
$HSPF_{ee}$		From application
$EFLH_{heating}$		Lookup based on building type, vintage and location from Appendix G.
$EER_{baseline}$		Lookup from Baseline Efficiencies table below based on product class and size.
EER_{ee}		From application
CF	0.69	

Coincidence Factor (CF)

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

[2] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by the Mid-Atlantic TRM Version 7.0 published May 2017 and by M. M. Straub, Using Available

Baseline Efficiencies from which Savings are Calculated

The baseline condition is an air source heat pump as defined in the Measure Description section above, with rated SEER, EER and HSPF per the table below. The SEER and HSPF values listed in the table below reflect the minimum performance required by federal standards. Minimum EER requirements are not specified by federal standards for the state of New York, nor are they mandated by state or city code for residential equipment. For this equipment, baseline EER is established as follows[3]:

$$EER = (1.12 \times SEER) - (0.02 \times SEER^2)$$

Resultant values from application of this equation are tabulated in the baseline efficiencies table below.

Product Class	Seasonal Energy Efficiency Ratio (SEER)[4]	Energy Efficiency Ratio (EER)	Heating Seasonal Performance Factor (HSPF)[5]
Split System – Heat Pump (<45 kBTUh)	14.0	11.8	8.2
Split System – Heat Pump (≥45 and < 65 kBTUh)	14.0	11.8	8.2
Single Package – Heat Pump	14.0	11.8	8.0

Compliance Efficiency from which Incentives are Calculated

The compliance condition is an air source heat pump as defined in the Measure Description section above meeting minimum performance requirements dictated by program guidelines.

Operating Hours

Cooling and heating EFLH data by location, building type and vintage are tabulated in Appendix G.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Minor heating interactions are expected with efficient furnace fans utilized in most high efficiency air conditioners. These impacts are expected to be negligible and have not been addressed in the prescribed methodology at this time.

Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011 and supported by research conducted by Cadmus on behalf of the TRM Management Committee.

[3] DOE, Building America House Simulation Protocols, October 2010

[4] 10 CFR 430.32 (c)(1)

[5] 10 CFR 430.32 (c)(1)

Ancillary Electric Savings Impacts

N/A

References

1. 10 CFR 430.2 Definitions.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
2. BG&E, Development of Residential Load Profile for Central Air Conditioners and Heat Pumps, via Mid-Atlantic Technical Reference Manual Version 7.0, May 2017 (accessed October 26, 2017)
   Available from:
   http://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V7_FINAL.pdf
3. M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011
   Available from: https://www.sciencedirect.com/science/article/pii/S1040619011001941
4. Building America House Simulation Protocols, Robert Hendron and Cheryn Engebrecht, National Renewable Energy Laboratory, October 2010
   Available from: https://www.nrel.gov/docs/fy11osti/49246.pdf
5. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8

Record of Revision

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1	10/15/2010
12-17-8	12/31/2017

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COMPRESSED AIR

AIR COMPRESSOR

Measure Description

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

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
hp_{comp}	= Horsepower of air compressor
(ΔkW/hp)	= Demand electric savings per horsepower
hrs	= Annual operating hours of air compressor
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
hp_{comp}		From application
(ΔkW/hp)		Lookup in table below based on compressor size and control strategy. [1]
hrs		From application
CF	0.8	

Air Compressor Deemed Savings (ΔkW/hp)

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

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8[2]

Baseline Efficiencies from which Savings are Calculated

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

Compliance Efficiency from which Incentives are Calculated

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

Operating Hours

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

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

Ancillary Electric Savings Impacts

N/A

References

N/A

Record of Revisions

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

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STORAGE TANK WATER HEATER

Measure Description

This measure covers the installation of gas and electric storage tank water heaters designed to heat and store water at a thermostatically controlled temperature. This measure applies to potable hot water delivery only; it is not applicable to hot water heaters used for process loads or space heating.

Storage type units include commercial gas storage water heaters with a nominal input of greater than 75,000 BTU per hour and less than 4,000 BTU per hour per gallon of stored water and commercial electric storage water heaters with a nominal input of greater than 12 kilowatts and less than 4,000 Btu per hour per gallon of stored water.[1]

This measure applies to replacement of existing storage type water heaters using the same heating fuel (gas or electric) as the proposed case. For new construction, this measure assumes baseline to be a standard efficiency water heater using the same heating fuel (gas or electric) as the proposed case.

This measure applies to commercial grade water heaters only. For residential-duty water heaters installed in commercial settings, the Residential Storage Tank and Instantaneous Domestic Water Heater methodology detailed in this document shall be employed utilizing typical GPD values as defined in the "Gallons per Day (GPD)" section below.

Method for Calculating Annual Energy and Peak Coincidence Demand Savings

Annual Electric Energy Savings (Electric Equipment Only)

$$\Delta kWh = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \left[\frac{1}{E_{t,baseline}} - \frac{1}{E_{t,ee}}\right]$$

Peak Coincident Demand Savings (Electric Equipment Only)

$$\Delta kW = units \times \frac{(UA_{baseline} - UA_{ee}) \times \Delta T_{amb}}{3{,}412} \times CF$$

Annual Gas Energy Savings (Gas Equipment Only)

$$\Delta therm = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{100{,}000} \times \left[\frac{1}{E_{t,baseline}} - \frac{1}{E_{t,ee}}\right]$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings

[1] 10 CFR 431.102

Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
GPD	= Gallons per day
ΔT_{main}	= Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	= Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
$_{baseline}$	= Baseline condition or measure
$_{ee}$	= Energy efficient condition or measure
E_t	= Thermal efficiency
UA	= Overall heat loss coefficient (BTU/hr-°F)
CF	= Coincidence factor
365	= Days in one year
8.33	= Energy required (BTU) to heat one gallon of water by one degree Fahrenheit
3,412	= Conversion factor, one kWh equals 3,412 BTU
100,000	= Conversion factor (BTU/therm), one therm equals 100,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
GPD		From application, or lookup/calculate based on building type, square footage and occupancy from GPD table below.
ΔT_{main}	T_{set} - T_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	(T_{set} - T_{amb})	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
T_{set}		Water heater set point temperature (°F), per application or use 140°F as a default.[2]
T_{main}		Supply water temperature in water main (°F). Lookup in Cold Water Inlet Temperature table below based on nearest city.
T_{amb}	70	Surrounding ambient air temperature (°F).[3]
$E_{t,baseline}$	Electric – 0.98 Gas – 0.80	Thermal efficiency of the baseline condition[4,5]
$E_{t,ee}$		Thermal efficiency for energy efficient measure, from application

[2] Per OSHA recommendations for prevention of Legionalla bacterial growth (https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html)
[3] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.
[4] Gas: 10 CFR 431.110 (a)
[5] Electric: Per 10 CFR 430 Subpart B Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters: *6.3.2 Recovery Efficiency*

Variable	Value	Notes
$UA_{baseline}$		Overall heat loss coefficient of the baseline condition (BTU/hr-°F). Calculate based on baseline standby loss per the Overall Heat Loss Coefficient section below.
UA_{ee}		Overall heat loss coefficient of the energy efficient measure (BTU/hr-°F). Calculate based on energy efficient standby loss per the Overall Heat Loss Coefficient section below.

Gallons per Day (GPD)

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

Building Type	GPD	Rate	Notes/Assumptions	Source
Assembly	239	7.02 GPD per 1,000 SF	Assumes 10% hot water, 34,000 SF	EIA[6]: Public Assembly
Auto Repair	25	4.89 GPD per 1,000 SF	Assumes 10% hot water, 5,150 SF	EIA: Other
Big Box Retail	448	3.43 GPD per 1,000 SF	Assumes 10% hot water, 130,500 SF	EIA: Mercantile
Community College	1,520	1.9 GPD per person	Assumes 800 students	NREL[7]: School with Showers
Dormitory	8,600	17.2 GPD per resident	Assumes 500 residents	Water Research Foundation[8]
Elementary School	250	0.5 GPD per student	Assumes 500 students	NREL: School
Fast Food Restaurant	500	500 GPD per restaurant		FSTC[9]: Quick Service
Full-Service Restaurant	2,500	2,500 GPD per restaurant		FSTC: Full Service
Grocery	172	3.43 GPD per 1,000 SF	Assumes 10% hot water, 50,000 SF	EIA: Mercantile
High School	1,520	1.9 GPD per person	Assumes 800 students	NREL: School with Showers
Hospital	16,938	54.42 GPD per 1,000 SF	Assumes 40% hot water, 250,000 SF	EIA: Health Care, Inpatient
Hotel	9,104	45.52 GPD per 1,000 SF	Assumes 40% hot water, 200,000 SF	EIA: Lodging
Large Office	550	1.1 GPD per person	Assumes 500 people	NREL: Office
Large Retail	446	3.43 GPD per 1,000 SF	Assumes 10% hot water, 130,000 SF	EIA: Mercantile
Light Industrial	489	4.89 GPD per 1,000 SF	Assumes 10% hot water, 100,000 SF	EIA: Other
Motel	1,366	45.52 GPD per 1,000 SF	Assumes 40% hot water, 30,000 SF	EIA: Lodging
Multifamily High-Rise	4,600	46 GPD per unit	Assumes 100 units	Water Research Foundation
Multifamily Low-Rise	552	46 GPD per unit	Assumes 12 units	Water Research Foundation
Refrigerated Warehouse	86	0.93 GPD per 1,000 SF	Assumes 10% hot water, 92,000 SF	EIA: Warehouse and Storage
Religious	77	7.02 GPD per 1,000 SF	Assumes 10% hot water, 11,000 SF	EIA: Public Assembly
Small Office	110	1.1 GPD per person	Assumes 100 people	NREL: Office
Small Retail	27	3.43 GPD per 1,000 SF	Assumes 10% hot water, 8,000 SF	EIA: Mercantile
University	1,000	0.5 GPD per student	Assumes 2,000 students	NREL: School
Warehouse	465	0.93 GPD per 1,000 SF	Assumes 10% hot water, 500,000 SF	EIA: Warehouse and Storage
Other	Calculate	4.89 GPD per 1,000 SF	Assumes 10% hot water	EIA: Other

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

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

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

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

Cold Water Inlet Temperature (T_{main})

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

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

Overall Heat Loss Coefficient ($UA_{baseline}$ and UA_{ee})

Tank overall heat loss coefficient is calculated from the equipment standby loss specification. For UA_{ee}, the manufacturer specified standby loss shall be applied directly to the UA formula below. To calculate $UA_{baseline}$, use the appropriate intermediate standby loss equation from the Baseline Standby Losses section below.

$$UA = \frac{SL}{70}$$

where:

SL = Standby heat loss (BTU/hr), from application for the energy efficient measure (SL_{ee}). For the baseline condition ($SL_{baseline}$), use the appropriate intermediate standby loss equation from the Baseline Standby Losses section below.

70 = Temperature difference associated with standby loss specification (°F)[12]

Baseline Standby Losses ($SL_{baseline}$)

Standby losses ($SL_{baseline}$) for commercial electric storage type water heaters:[13]

$$SL_{baseline} = 20 + 35\sqrt{v_{baseline}}$$

where:

$v_{baseline}$ = Baseline tank volume (gal), equal to the storage capacity of the proposed equipment

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

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

[12] 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters

[13] Ibid.

Standby losses ($SL_{baseline}$) for commercial gas storage type water heaters:[14]

$$SL_{baseline} = \frac{Q_{baseline}}{800} + 110\sqrt{v_{baseline}}$$

where:
$v_{baseline}$ = Baseline tank volume (gal), equal to the storage capacity of the proposed equipment
$Q_{baseline}$ = Baseline input capacity (BTU/hr), equal to the input capacity of the proposed equipment

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8[15]

Baseline Efficiencies from which Savings are Calculated

The baseline condition for replacement measures is a standard efficiency gas or electric storage type water heater (based on proposed conditions) with tank volume and input capacity equivalent to the proposed case, UA value calculated as prescribed above and a thermal efficiency of 0.80 (gas) or 0.98 (electric).

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a gas or electric storage type water heater as defined in the Measure Description section above meeting minimum performance requirements dictated by program eligibility criteria.

Effective Useful Life (EUL)

See Appendix P.

Operating Hours

Water heater run hours are not utilized in the estimation of energy or demand savings, but water heater is assumed to be available for operation 8,760 hours per year. Additionally, it is assumed standby losses are incurred 8,760 hours per year.

Ancillary Fossil Fuel Savings Impacts

Reduction in standby heat losses will have a negligible impact on space heating when the water heater is located in conditioned space. Consideration of these effects is not included in this methodology.

[14] 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters
[15] *No source specified – update pending availability and review of applicable references.*

Ancillary Electric Savings Impacts

High-efficiency water heaters may incorporate a draft fan, which increases electricity consumption. Additionally, reduction in standby heat losses will have a negligible impact on space heating and cooling when the water heater is located in conditioned space. Consideration of these effects is not included in this methodology.

References

1. 10 CFR 431.102 Definitions concerning commercial water heaters, hot water supply boilers, unfired hot water storage tanks, and commercial heat pump water heaters. Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=863517ec5f69fb78dad68864aa84c128&mc=true&n=sp10.3.431.g&r=SUBPART&ty=HTML#se10.3.431_1102
2. OSHA Legionnaire's Disease eTool: Section II: C-1. Domestic Hot-Water Systems Available from: https://www.osha.gov/dts/osta/otm/legionnaires/hotwater.html
3. 10 CFR 430 Subpart B – Test Procedures, Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=9624a8ba0987aaae248454c49194a661&mc=true&n=pt10.3.430&r=PART&ty=HTML#ap10.3.430_127.e
4. 10 CFR 431.110 Energy conservation standards and their effective dates Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=64f994924a5f31b841cab23a6d543f85&mc=true&node=pt10.3.431&rgn=div5#se10.3.431_1110
5. U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey: Water Consumption in Large Buildings, Table WD1. Daily water consumption in large commercial buildings, 2012 Available from: https://www.eia.gov/consumption/commercial/reports/2012/water/
6. National Renewable Energy Laboratory, Saving Energy in Commercial Buildings: Domestic Hot Water Assessment Guidelines, Table 1. Hot Water Use By Building Type, June 2011 Available from: https://www.nrel.gov/docs/fy11osti/50118.pdf
7. Water Research Foundation: "Residential End Uses of Water, Version 2: Executive Report", April 2016 Available from: http://www.waterrf.org/PublicReportLibrary/4309A.pdf
8. Food Service Technology Center, Design Guide – Energy Efficient Heating, Delivery and Use, Table 1. Typical hot water system cost for restaurants, March 2010 Available from: https://fishnick.com/design/waterheating/Water_Heating_Design_Guide_Final_FNi_disclaimer.pdf
9. Burch, Jay and Craig Christensen; "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory. Available from: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.515.6885

10. NOAA National Centers for Environmental Information – NCDC 1981-2010 Climate Normals
11. 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters
Available from:
https://energy.gov/sites/prod/files/2016/08/f33/Water%20Heaters%20Test%20Procedure%20SNOPR.pdf

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
12-17-10	12/31/2017

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UNITARY AIR CONDITIONER AND UNITARY & APPLIED HEAT PUMP

Measure Description

This measure covers installation of high-efficiency unitary air conditioners and unitary and applied heat pumps in commercial applications. The baseline case shall be minimally code compliant equipment of the same type and capacity as in the proposed case, which shall be sized in accordance with federal, state and local energy conservation code.

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, and 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 and applied 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

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

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

[1] AHRI Standard 340/360 – 2015 & AHRI Standard 210/240 with Addenda 1 and 2 – 2012
[2] Ibid.

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
tons	= Output cooling capacity in tons (at AHRI standard rating conditions)
kBtuh	= Output heating capacity in kBTU/h (at AHRI standard high-temperature rating conditions)
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure
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, 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 under peak conditions in BTU/watt-hour. Measurement of the cooling capacity for a unit in BTU/hr divided by the connected electric power of the unit in 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 divided by the total electric energy heat pump consumed in watt-hours (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

[3] AHRI Standard 340/360 – 2015 & AHRI Standard 210/240 with Addenda 1 and 2 – 2012

$EFLH_{heating}$ = Heating equivalent full-load hours
CF = Coincidence factor
12 = kBTUh/ton of air conditioning capacity
3.412 = Conversion factor, one watt/h equals 3.412142 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application
kBTUh		From application
$SEER_{baseline}$		Lookup from Baseline Efficiencies table below based on equipment type, size category and applicable code.
$SEER_{ee}$		From application
$HSPF_{baseline}$		Lookup from Baseline Efficiencies table below based on equipment type, size category and applicable code.
$HSPF_{ee}$		From application
$IEER_{baseline}$		Lookup from Baseline Efficiencies table below based on equipment type, size category and applicable code.
$IEER_{ee}$		From application
$COP_{baseline}$		Lookup from Baseline Efficiencies table below based on equipment type, size category and applicable code.
COP_{ee}		From application
$EER_{baseline}$		Lookup from Baseline Efficiencies table below based on equipment type, size category and applicable code.
EER_{ee}		From application
$EFLH_{heating}$		From application. If unknown, lookup based on building type and location from Appendix G.
$EFLH_{cooling}$		From application. If unknown, lookup based on building type and location from Appendix G.
CF	0.8	

The **SEER** is an estimate of the seasonal energy efficiency for an average US city for small units <65,000 BTUh cooling output.

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. Larger units are rated in IEER.

The **COP** is a ratio of the heating capacity in watts to the power input value in watts at any given set of AHRI Standard Rating Conditions.

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

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8.[4]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is defined as minimally code compliant equipment of type and cooling and heating capacities equivalent to the proposed case. The baseline efficiencies for unitary air conditioning and unitary and applied heat pump equipment are specified in the table below, as defined by International Energy Conservation Code and subsequently adopted by the Energy Conservation Construction Code of New York State[5] (ECCCNYS), and the New York City Energy Conservation Code[6] (NYCECC). EER requirements are not specified by state or city code for equipment with <65,000 Btu/h cooling capacity. For this equipment, baseline EER are established as follows[7]:

$$EER = (1.12 \times SEER) - (0.02 \times SEER^2)$$

Resultant values from application of this equation to equipment with <65,000 Btu/h cooling capacity are tabulated in the baseline efficiencies table below.

Federal energy conservation standards[8] effective January 1, 2018 for small, large and very large package air conditioning and heating equipment supersede NYS and NYC code as indicated in the table below.

Unitary Air Conditioners					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**Baseline Efficiency (NYS)**	**Baseline Efficiency (NYC)**
Air conditioners (air cooled)	< 65,000 Btu/h (single phase)	All	Split System	11.2 EER 13.0 SEER	11.2 EER 13.0 SEER
			Single Package	11.8 EER 14.0 SEER	11.8 EER 14.0 SEER
Through-the-wall (air cooled)	≤ 30,000 Btu/h (single phase)	All	Split System	10.6 EER 12.0 SEER	10.6 EER 12.0 SEER
			Single Package	10.6 EER 12.0 SEER	10.6 EER 12.0 SEER
Small-duct high-velocity (air cooled)	< 65,000 Btu/h (single phase)	All	Split System	9.9 EER 11.0 SEER	9.9 EER 11.0 SEER

[4] *No source specified – update pending availability and review of applicable references.*
[5] ECCCNYS 2016, Table C403.2.3(1) & Table C403.2.3(2)
[6] NYCECC 2016; Table C403.2.3(1) & Table C403.2.3(2)
[7] DOE, Building America House Simulation Protocols, October 2010
[8] 10 CFR 431.97 (Table 3)

Unitary Air Conditioners					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**Baseline Efficiency (NYS)**	**Baseline Efficiency (NYC)**
Air conditioners (air cooled)	≥ 65,000 Btu/h and < 135,000 Btu/h[9]	Electric Resistance (or None)	Split System and Single Package	11.2 EER 12.9 IEER	11.2 EER 12.9 IEER
		All Other	Split System and Single Package	11.0 EER 12.7 IEER	11.0 EER 12.7 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

[9] For equipment with ≥65,000 Btu/h and <135,000 Btu/h cooling capacity, IEER values are taken from 10 CFR 431.97 (Table 3)

Unitary and Applied Heat Pumps					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**Baseline Efficiency NYS**	**Baseline Efficiency NYC**
Cooling					
Air cooled (cooling mode)	< 65,000 Btu/h (single phase)	All	Split System	11.8 EER 14.0 SEER	11.8 EER 14.0 SEER
			Single Package	11.8 EER 14.0 SEER	11.8 EER 14.0 SEER
Through-the-wall (air cooled)	≥ 30,000 Btu/h (single phase)	All	Split System	10.6 EER 12.0 SEER	10.6 EER 12.0 SEER
			Single Package	10.6 EER 12.0 SEER	10.6 EER 12.0 SEER
Single-duct high-velocity (air cooled)	< 65,000 Btu/h (single phase)	All	Split System	9.9 EER 11.0 SEER	9.9 EER 11.0 SEER
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h[10]	Electric Resistance (or None)	Split System and Single Package	11.0 EER 12.2 IEER	11.0 EER 12.2 IEER
		All other	Split System and Single Package	10.8 EER 12.0 IEER	10.8 EER 12.0 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[11]	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 10.4 IEER	9.3 EER 10.4 IEER

[10] For equipment with ≥65,000 Btu/h and <135,000 Btu/h cooling capacity, IEER values are taken from 10 CFR 431.97 (Table 3)

[11] For equipment with ≥240,000 Btu/h cooling capacity, IEER values are taken from 10 CFR 431.97 (Table 3)

Unitary and Applied Heat Pumps					
Equipment Type	**Size Category (Cooling Capacity)**	**Heating Section Type**	**Subcategory or Rating Condition**	**Baseline Efficiency NYS**	**Baseline Efficiency NYC**
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
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

The compliance condition is a high efficiency unitary air conditioning or unitary/applied heat pump system as defined in the Measure Description section above meeting minimum performance requirements dictated by program eligibility criteria.

Operating Hours

Equipment heating and cooling equivalent full load hours shall be taken from the application. If unknown, default EFLH by facility type and location can be found in Appendix G.

Effective Useful Life (EUL)

See Appendix P.

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
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   http://ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_340-360_2015.pdf
2. AHRI Standard 210/240 with Addenda 1 and 2, 2008 Standard for Performance Rating of Unitary Air-Conditioning & Air Source Heat Pump Equipment, December 2012
   Available from:
   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. C&I Unitary HVAC Load Shape Project Final Report, KEMA, August 2, 2011, Table 0-6 & Table 0-7
   Available from:
   http://www.neep.org/sites/default/files/resources/NEEP_HVAC_Load_Shape_Report_Final_August2.pdf
4. ECCCNYS 2016, per IECC 2015; Table C403.2.3(1): Minimum Efficiency Requirements: Electrically Operated Unitary Air Conditioners and Condensing Units & Table C403.2.3(2): Minimum Efficiency Requirements: Electrically Operated Unitary and Applied Heat Pumps
   Available from: https://codes.iccsafe.org/public/document/code/444/7965605
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
   Available from:
   https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHC4.pdf&section=energy_code_2016
6. Building America House Simulation Protocols, Robert Hendron and Cheryn Engebrecht, National Renewable Energy Laboratory, October 2010
   Available from: https://www.nrel.gov/docs/fy11osti/49246.pdf
7. 10 CFR 431.97: Energy Efficiency Standards and Their Compliance Dates, Table 3: Updates to the Minimum Cooling Efficiency Standards for Air Conditioning and Heating Equipment
   Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=69945fdbe7327d148adc5e11b79bda36&node=se10.3.431_197&rgn=div8

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1	10/15/2010
1-17-5	12/31/2016
12-17-11	12/31/2017

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CHILLER - COOLING TOWER

Measure Description

This measure covers the installation of close approach cooling towers applied to water-cooled chillers used for space cooling. Consumption and peak coincident demand savings are achieved through the installation of an over-sized cooling tower designed to provide an approach of ≤ 6°F at standard rating conditions. This measure addresses approach temperature only, which is defined as the difference between the cold water temperature (cooling tower outlet) and ambient wet bulb temperature. Changes in condenser water set point control strategies are not included.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times tons \times (\Delta kWh/ton)$$

Peak Coincident Demand Savings

$$\Delta kW = units \times tons \times (\Delta kW/ton) \times CF$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
units	= Number of measures installed under the program
tons	= Size of cooling system (in tons) being retrofitted with a close approach tower
(ΔkWh/ton)	= Annual electric energy savings per ton of cooling
(ΔkW/ton)	= Electric demand savings per ton of cooling
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application
(ΔkWh/ton)		Annual electric energy savings per ton of cooling system retrofitted with close approach tower. Look up in Appendix J based on building type, HVAC type and location.
(ΔkW/ton)		Electric demand savings per ton of cooling system retrofitted with close approach tower. Look up in Appendix J based on building type, HVAC type and location
CF	0.8	

Unit energy savings were calculated from a DOE-2.2 simulation of commercial buildings with built-up HVAC systems. The prototype building characteristics are described in Appendix A. The unit energy savings by building type across different cities in NY are shown in Appendix J.

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8.[1]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a standard cooling tower with a 10°F approach temperature under standard rating conditions.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a close approach cooling tower with a 6°F approach temperature under standard rating conditions.

Operating Hours

The HVAC system operating hours vary by building type. Operating hour assumptions for the prototypical building models are described in Appendix A.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

N/A

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1	10/15/2010
12-17-12	12/31/2017

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

FURNACE AND BOILER

Measure Description

This measure covers high-efficiency gas-fired furnaces, boilers and unit heaters used for space heating installed in all buildings except low-rise residential (single and multifamily) applications. The baseline case shall be minimally code compliant equipment of the same type and capacity as in the proposed case, which shall be sized in accordance with federal, state and local energy conservation code.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = units \times \left(\frac{kBTUh_{in}}{unit}\right) \times \left(\frac{\eta_{ee}}{\eta_{baseline}} - 1\right) \times \left(\frac{EFLH_{heating}}{100}\right)$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
$kBTUh_{in}$	= Fuel input rating of the proposed equipment
$_{baseline}$	= Baseline condition or measure
$_{ee}$	= Energy efficient condition or measure
η	= Energy efficiency (0-100%)
$EFLH_{heating}$	= Heating equivalent full-load hours
100	= Conversion factor, one therm equals 100 kBTU

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTUh_{in}$/unit		Nameplate input rating of the proposed unit, from application.
$\eta_{baseline}$		Baseline established by applicable energy conservation code, climatic zone, equipment type and size, fuel source, and system configuration. See Baseline Efficiency section below.
η_{ee}		From application.
$EFLH_{heating}$		From application. If unknown, lookup based on building type and location from Appendix G.

Efficiency is expressed as the ratio of the fuel input relative to the output heating capacity. The efficiency of furnaces, boilers and unit heaters is customarily evaluated on the basis of one or more of three standards, namely Thermal Efficiency (E_t), Combustion Efficiency, (E_c) and Annual Fuel Utilization Efficiency (AFUE).

Presently, the AFUE value is only applicable to smaller units (<300 kBTUh for boilers and <225 kBTUh for furnaces). For larger units, use thermal and combustion efficiencies referenced on manufacturer's nameplate data in accordance with nationally recognized standards and testing agencies.

Coincidence Factor (CF)

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

Baseline Efficiencies From Which Savings are Calculated

The baseline condition is a minimally code compliant system of type and capacity equivalent to the proposed condition. The baseline efficiency for commercial furnaces, boilers, and unit heaters ($\eta_{baseline}$) is defined by the Code of Federal Regulations (CFR) and subsequently adopted by the Energy Conservation Construction Code of New York State[1] and the New York City Energy Conservation Code[2] as shown below.

Equipment Type	Size Range	ECCCNYS Minimum Efficiency for Climate Zones 4, 5 and 6	NYCECC Minimum Efficiency for NYC Boroughs in Climate Zone 4
Warm Air Furnace, Gas Fired	< 225 kBTU/h	78% AFUE or 80% E_t	78% AFUE or 80% E_t
	≥ 225 kBTU/h	80% E_t	80% E_t
Warm Air Unit Heaters, Gas Fired	All Capacities	80% E_c	80% E_c
Boiler, Hot Water, Gas Fired	< 300 kBTU/h	80% AFUE	80% AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	80% E_t	80% E_t

[1] ECCCNYS 2016, Table C403.2.3(4) and Table C403.2.3(5)
[2] NYCECC 2016; Table C403.2.3(4) and Table C403.2.3(5)

	> 2,500 kBTU/h	82% E_c	82% E_c
Boiler, Steam, Gas Fired, All Except Natural Draft	< 300 kBTU/h	75% AFUE	75% AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	79% E_t	79% E_t
	> 2,500 kBTU/h	79% E_t	79% E_t
Boiler, Steam, Gas Fired, Natural Draft	< 300 kBTU/h	75% AFUE	75% AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	77% E_t	77% E_t
	> 2,500 kBTU/h	77% E_t	77% E_t

Compliance Efficiencies From Which Incentives are Calculated

The compliance condition is a gas-fired furnace, boiler or unit heater used for space heating as defined in the Measure Description section above meeting minimum performance requirements dictated by program eligibility criteria.

Operating Hours

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

High efficiency furnaces may be packaged with high efficiency cooling equipment and/or electronically commutated blower motors, which may provide electricity savings. Draft fans, when present, will increase electricity consumption. These ancillary impacts are not included in the savings estimation approach detailed above.

References

1. ECCCNYS 2016, per IECC 2015; Table C403.2.3(4): Warm-Air Furnaces And Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces And Unit Heaters, Minimum Efficiency Requirements & Table C403.2.3(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers.
Available from: https://codes.iccsafe.org/public/document/code/444/7965605

2. NYCECC 2016; Table C403.2.3(4): Warm-Air Furnaces And Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces And Unit Heaters, Minimum Efficiency Requirements & Table C403.2.3(5): Minimum Efficiency Requirements: Gas- And Oil-Fired Boilers
   Available from:
   https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHC4.pdf&section=energy_code_2016

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1	10/15/2010
6-15-7	6/1/2015
1-16-4	12/31/2015
12-17-13	12/31/2017

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AIR CONDITIONER AND HEAT PUMP – PACKAGED TERMINAL

Measure Description

This measure covers installation of high efficiency unitary air conditioners and unitary and applied heat pumps in commercial applications. The baseline case shall be minimally code compliant equipment of the same type and capacity as in the proposed case, which shall be sized in accordance with federal, state and local energy conservation code.

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.

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.*[1]

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

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

Peak Coincident Demand Savings

[1] AHRI Standard 310/380 – 2014
[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.

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

Annual Gas Energy Savings

$$\Delta therm = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
$kBTUh_{cooling}$	= 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)
$EFLH_{cooling}$	= Cooling equivalent full-load hours
$EFLH_{heating}$	= Heating equivalent full-load hours
3.412	= Conversion factor, one watt/h equals 3.412142 BTU
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTUh_{cooling}$		From application
$kBTUh_{heating}$		From application
$COP_{baseline}$		Calculate from Baseline Efficiencies table below based on equipment type, size category and capacity.
COP_{ee}		From application
$EER_{baseline}$		Calculate from Baseline Efficiencies table below based on equipment type, size category and capacity.
EER_{ee}		From application
$EFLH_{heating}$		From application. If unknown, lookup based on building type and location from Appendix G.
$EFLH_{cooling}$		From application. If unknown, lookup based on building type and location from Appendix G.
CF	0.8	

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8.[4]

Baseline Efficiencies from which Savings are Calculated

The baseline condition is defined as minimally code compliant equipment of type and cooling and heating capacities equivalent to the proposed case. The baseline efficiencies are calculated based on rated equipment input capacity in BTU/h and are defined by International Energy Conservation Code[5] and subsequently adopted by the Energy Conservation Construction Code of New York State (ECCCNYS) and the New York City Energy Conservation Code[6] (NYCECC) as shown below. The formulas in the rightmost column shall be used to establish the baseline efficiency in the units specified (EER or COP).

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency ECCCNYS and NYCECC[7]
PTAC (Cooling Mode) Standard Size	All Capacities	95°F db Outdoor Air	EER = 14.0 - (0.300 × Cap/1000)
PTAC (Cooling Mode) Replacements/ Nonstandard Size[8]	All Capacities	95°F db Outdoor Air	EER = 10.9 - (0.213 × Cap/1000)
PTHP (Cooling Mode) Standard Size	All Capacities	95°F db Outdoor Air	EER = 14.0 - (0.300 × Cap/1000)
PTHP (Cooling Mode) Replacements/ Nonstandard Size	All Capacities	95°F db Outdoor Air	EER = 10.8 - (0.213 × Cap/1000)
PTHP (Heating Mode) Standard Size	All Capacities	—	NY State: COP = 3.2 – (0.026 × Cap/1000) NYC: COP = 3.7 – (0.052 × Cap/1000)
PTHP (Heating Mode) Replacements/ Nonstandard Size	All Capacities	—	COP = 2.9 - (0.026 × Cap/1000)

[4] *No source specified – update pending availability and review of applicable references.*
[5] ECCCNYS 2016, Table C403.2.3(3)
[6] NYCECC 2016, Table C403.2.3(3)
[7] "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."
[8] Replacement/Nonstandard size units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement/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.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a high efficiency packaged terminal air conditioner or heat pump system as defined in the Measure Description section above meeting minimum performance requirements dictated by program eligibility criteria.

Operating Hours

Equipment heating and cooling equivalent full load hours shall be taken from the application. If unknown, default EFLH by facility type and location can be found in Appendix G.

Effective Useful Life (EUL)

See Appendix P.

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
   Available from:
   http://www.ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_310_380-2014_CSA_C744-14.pdf
2. C&I Unitary HVAC Load Shape Project Final Report, KEMA, August 2, 2011, Table 0-6
   Available from:
   http://www.neep.org/sites/default/files/resources/NEEP_HVAC_Load_Shape_Report_Final_August2.pdf
3. ECCCNYS 2016, per IECC 2015; Table C403.2.3(3): Minimum Efficiency Requirements: Electrically Operated Unitary 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
   Available from: https://codes.iccsafe.org/public/document/code/444/7965605
4. NYCECC 2016; Table C403.2.3(3): Minimum Efficiency Requirements: Electrically Operated Unitary 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
   Available from:
   https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHC4.pdf&section=energy_code_2016

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1	10/15/2010
1-17-6	12/31/2016
12-17-14	12/31/2017

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APPENDIX P

EFFECTIVE USEFUL LIFE (EUL)

SINGLE AND MULTI-FAMILY RESIDENTIAL MEASURES

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Appliance	Advanced Power Strips	Residential	8	DEER 2014 EUL ID: Plug-OccSens
	Clothes Washer	Single-family	11	DEER 2014 EUL ID: Appl-EffCW
		Multifamily	14	DOE 2014
	Clothes Dryer	Residential	14	ESTAR M&I Scoping Report[1]
	Dehumidifier	Residential	12	US EPA[2]
	Air Purifier (Cleaner)	Residential	9	ESTAR Appliance Calc[3]
	Dishwasher	Residential	11	DEER
	Refrigerator Replacement	Residential	17	NYS DPS
Appliance Recycling	Air Conditioner - Room (RAC), Recycling	Residential	3	DEER[4]
	Refrigerator Recycling	Residential	5	DEER 2014 EUL ID: Appl-RecRef
	Freezer Recycling	Residential	4	DEER 2014 EUL ID: Appl-RecFrzr
Building Shell	Air Leakage sealing	Residential	15	GDS[5]
	Hot Water Pipe Insulation	Residential	13 – Electric 11 – Gas	DEER
	Opaque Shell Insulation	Residential	30	Energy Trust of Oregon and CEC[6]
	Window & Through the wall AC cover and Gap Sealer	Residential	5	See note below[7]
	Window Replacement	Residential	20	DEER 2014 EUL ID: BS-Win

[1] ENERGY STAR Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[2] ENERGY STAR Dehumidifier Calculator
www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDehumidifier.xls
[3] Savings Calculator for ENERGY STAR® Qualified Appliances (last updated October 2016)
Available from: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products
[4] IBID
[5] IBID
[6] http://energytrust.org/library/reports/resource_assesment/gasrptfinal_ss103103.pdf
[7] At least one manufactures warranty period. www.gss-ee.com/products.html

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Domestic Hot Water	Domestic Hot Water Tank Blanket	Residential	10	NYSERDA[8]
	Heat Pump Water Heater – Air Source (HPWH)[9]	Residential	10	DEER 2014 EUL ID: WtrHt-HtPmp
	Indirect Water Heater	Residential	11	DEER 2014 EUL ID: WtrHt-Res-Gas
	Storage Water Heater - Gas	Residential	11	DEER 2014 EUL ID: WtrHt-Res-Gas
	Storage Water Heater - Electric	Residential	13	DEER 2014 EUL ID: WtrHt-Res-Elec
	Instantaneous Water Heater	Residential	20	DEER 2014 EUL ID: WtrHt-Instant-Res
Domestic Hot Water - Control	Faucet – Low Flow Aerator	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Shower Restriction Valve	Residential	10	UPC[10]
	Shower Head – Low Flow	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
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[11]
	Air Conditioner, Central (CAC)	Residential	15	DEER 2014 EUL ID: HV-ResAC
	Air Conditioner – Room (RAC)	Residential	9	DEER
	Boiler, Hot Water – Steel Water Tube	Residential	24	ASHRAE Handbook, 2015
	Boiler, Hot Water – Steel Fire Tube	Residential	25	ASHRAE Handbook, 2015
	Boiler, Hot Water – Cast Iron	Residential	35	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Water Tube	Residential	30	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Fire Tube	Residential	25	ASHRAE Handbook, 2015

[8] NYSERDA Energy Smart Program Deemed Savings Database. Rev 9 – 062006

[9] Electric heat pump used for service hot water heating

[10] 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.

[11] Savings assumed to persist over EUL of air conditioner or heat pump

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Boiler, Steam – Cast Iron	Residential	30	ASHRAE Handbook, 2015
	Circulator – with Electronically Commuted Motor (ECM) for Hydronic distribution	Residential	15	DEER[12]
	Duct sealing and Insulation	Residential	18	DEER
	Fan Motor – with Electronically Commuted Motor (ECM) for Furnace Distribution	Residential	15	DEER 2014 EUL ID: Motors-fan
	Furnace, Gas Fired	Residential	22	DOE[13,14]
	Furnace Tune-up	Residential	5	See note below[15]
	Heat Pump - Air Source	Residential	15	DEER 2014 EUL ID: HV-Res HP
	Heat Pump – Ground Source	Residential	25	ASHRAE[16]
	Unit Heater, Gas Fired	Residential	13	ASHRAE Handbook, 2015
HVAC - Control	Outdoor Reset Control for Hydronic Boiler	Residential	15	ACEEE[17]
	Thermostat – Programmable; Thermostat – Wi-Fi Communicating	Residential	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve	Multifamily	12	NYS DPS

[12] Based on DEER value for furnace fans

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

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

[15] Reduced from DEER value of 10 years

[16] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://energy.gov/energysaver/geothermal-heat-pumps

[17] 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 Inst. – 7	GDS
			Markdown - 7	GDS
		Multifamily Common area	9,000 hrs/ annual lighting operating hrs	See note below[18]
	LED Lamps (Directional)	Residential/ Multifamily Common area	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Lamps[19]
			35,000 or 50,000 hours	DLC[20]
	LED Lamps (Decorative & Omnidirectional)	Residential/ Multifamily Common area	15,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Lamps

[18] 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

[19] 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

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

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
Lighting	Light Fixture	LED (Interior)	Residential/ Multifamily	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Fixtures[21]
		LED (Exterior)	Residential/ Multifamily Common area	35,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Fixtures
		Linear Fluorescent	Residential / Multifamily Common area	70,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	DEER 2014[22] EUL ID: ILtg-Lfluor-CommArea
		CFL	Residential / Multifamily Common area	22,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	See note below[23]
Lighting Control	Stairwell Dimming Light Fixture/Sensor		Multifamily	12	GDS[24]

[21] 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

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

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

[24] 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[142]
Appliance	Advanced Power Strips	C&I	8	DEER 2014 EUL ID: Plug-OccSens
	Clothes Dryer	C&I	14	ESTAR M&I Scoping Report[143]
	Electric Cooking Equipment (Oven, Fryer, Steamer)	C&I	12	DEER
	Gas Fired Cooking Equipment (Oven, Griddle, Fryer, Steamer)	C&I	12	DEER
	Room Air Conditioner Recycling	C&I	9	DEER 2014 EUL ID: HV-RAC-ES
	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 2014 EUL ID: BS-Win
	Opaque Shell Insulation	C&I	30	Energy Trust and CEC[144]
Compressed Air	Air Compressor Upgrade	C&I	13	State TRMs[145]
	Refrigerated Air Dryer	C&I	15	Ohio TRM
	Engineered Air Nozzle	C&I	15	PA Consulting for Wisconsin PSC[146]
	No Air Loss Water Drain	C&I	15	Ohio TRM[147]
Domestic Hot Water (DHW)	Domestic Hot Water Tank Blanket	C&I	7	DEER
	Indirect Water Heater	C&I	15	DEER[148]
	Storage Tank Water Heater	C&I	15	DEER 2014 EUL ID: WtrHt-Com
	Tankless Water Heater	C&I	20	DEER
	Heat Pump Water Heater - Air Source (HPWH)	C&I	10	DEER

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

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

[144] 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

[145] Based on a review of TRM assumptions from Ohio (August 2010), Massachusetts (October 2015), Illinois (February 2017) and Vermont (March 2015). Estimates range from 10 to 15 years.

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

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

[148] EUL for commercial central water heater used

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
DHW - Control	Faucet – Low Flow Aerator	C&I	10	DEER
	Showerhead – Low Flow	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Pre-Rinse Spray Valve	C&I	5	GDS
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner and Heat Pump – Refrigerant Charge Correction	C&I	10	DEER
	Air Conditioner – Unitary	C&I	15	DEER 2014 EUL ID: HVAC-airAC
	Air Conditioner – PTAC	C&I	15	DEER 2014 EUL ID: HVAC-PTAC
	Chiller – Air & Water Cooled	C&I	20	DEER 2014 EUL ID: HVAC-Chlr
	Chiller – Cooling Tower	C&I	15	DEER 2014 EUL ID: ClTwrPkgSys
	Chiller Tune-Up	C&I	5	WI EUL DB[149]
	Combination Boiler and Water Heater	C&I	20	DEER[150]
	Condensing Gas-Fired Unit Heater for Space Heating	C&I	18	Ecotope[151]
	Duct Sealing and Insulation	C&I	18	DEER
	ECM Motors on HVAC Equipment	C&I	15	DEER[152]
	Economizer – Air Side, w/dual enthalpy control	C&I	10	DEER
	Boiler, Hot Water – Steel Water Tube	C&I	24	ASHRAE Handbook, 2015
	Boiler, Hot Water – Steel Fire Tube	C&I	25	ASHRAE Handbook, 2015
	Boiler, Hot Water – Cast Iron	C&I	35	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Water Tube	C&I	30	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Fire Tube	C&I	25	ASHRAE Handbook, 2015
	Boiler, Steam – Cast Iron	C&I	30	ASHRAE Handbook, 2015

[149] Wisconsin Public Service Commission: Equipment Useful Life Database, 2013
Excerpt available from:
https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[150] Based on DEER value for high efficiency boiler
[151] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003)
[152] DEER value for HVAC fan motors

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Boiler Tune-Up	C&I	5	DEER 2014 EUL ID: BlrTuneup
	Furnace, Gas Fired	C&I	23	DOE[153],[154]
	Unit Heater, Gas Fired	C&I	13	ASHRAE Handbook, 2015
	Heat Pump – Unitary & Applied	C&I	15	DEER 2014 EUL ID: HVAC-airHP
	Heat Pump – PTHP	C&I	15	DEER 2014 EUL ID: HVAC-PTHP
	Infrared Gas Space Heater	C&I	17	GDS
HVAC - Control	Thermostat – Programmable Thermostat – Wi-Fi Communicating	C&I	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Boiler Reset Control	C&I	15	See note below[155]
	Demand Controlled Ventilation	C&I	15	DEER 2014 EUL ID: HVAC-VSD-DCV
	Energy Management System	C&I	15	DEER
	Hotel Occupancy Sensors for PTAC and HP Units	C&I	8	DEER[156]
	Steam Traps Repair/Replace	C&I	6	DEER 2014 EUL ID: HVAC-StmTrp
Lighting	CFL Lamp	C&I	9,000 hours /annual lighting operating hours	See note below[157]
	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

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

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

[155] Set to 15 years, consistent with Energy Management System (EMS) value in DEER

[156] DEER value for occupancy sensor controls. Hardwired (not battery powered) controls only

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

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting	Linear Fluorescent	C&I	70,000 hours /annual lighting operating hours or 15 years, (whichever is less)	DEER 2014[158] EUL ID: ILtg-Lfluor-Elec
	LED Fixtures (other than refrigerated case)	C&I	50,000 hours /annual lighting operating hours or 20 years (whichever is less)	DLC[159]
			35,000 hours /annual lighting operating hours or 20 years (whichever is less)	Energy Star[160]
			25,000 hours /annual lighting operating hours or 20 years (whichever is less)	Uncertified
	Refrigerated Case LED	C&I	16	DEER 2014 EUL ID: GrocDisp-FixtLtg-LED
	LED Screw-In Lamps	C&I	15,000 hours (decorative) or 25,000 hours (all other)/ annual lighting operating hours or 20 years (whichever is less)	Energy Star
Lighting - Control	Interior Lighting Control	C&I	8	DEER 2014 EUL IDs: GlazDayIT-Dayltg, ILtg-OccSens
	Stairwell Dimming Light Fixture/Sensor	C&I	12	GDS[161]

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

[159] 50,000 hours per L_{70} requirements prescribed by the DLC's Product Qualification Criteria, Technical Requirement Table version 4.2

[160] Placed on the Qualified Fixture List by Energy Star, according to the appropriate luminaire classification as specified in the Energy Star Program requirements for Luminaires, version 2.0. Divided by estimated annual use, but capped at 20 years regardless (consistent with C&I redecoration and business type change patterns

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

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
	Plug-Load Occupancy Sensor	C&I	8	DEER[162]
Motors and Drives	Motor replacement (with HE motor)	C&I	15	DEER
	Variable Frequency Drive – Fan and Pump	C&I	15	DEER 2014 EUL IDs: HVAC-VSDSupFan
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 2014 EUL ID: GrocDisp-FEvapFanMtr
	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 2014 EUL ID: GrocDisp-ASH
	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
6-17-16	6/30/2017
9-17-11	9/30/2017
12-17-17	12/31/2017

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[162] 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)
ΔkW	Peak coincident demand electric savings
ΔkWh	Annual electric energy savings
ΔQ	Heat difference/loss
ΔT	Temperature difference
Δtherms	Annual gas energy savings
Δ	Change, difference, or savings
A	Amperage
AC	Air conditioning
ACCA	Air Conditioning Contractors of America
ACEEE	American Council for an Energy-Efficient Economy
ACL	Actual cooling load (Btu/hr) based on Manual J calculation
ACH	Air change per hour
AFUE	Annual fuel utilization efficiency, seasonal energy efficiency for fuel heating equipment
AHAM	Association of Home Appliance Manufacturers
AHL	Actual heating load (Btu/hr) based on Manual J calculation
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
baseline	Baseline condition or measure
BLDC	Brushless DC electric motor
BTU	British Thermal Unit
BTUh	British Thermal Units per hour
CAC	Central air conditioner
CADR	Clean Air Delivery Rate (CFM)
Capacity	Cooling output rating, in Btu/hr
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
CEF	Combined energy factor (lb/kWh)
CEER	Combined Energy Efficiency Ratio
CF	Coincidence factor
CFL	Compact fluorescent lamp
CFM	Cubic foot per minute
CHW	Chilled water
CHWP	Chilled water pump
CLH	Cooling load hours
CM	Case motor
CMU	Concrete masonry
$Comp_{eff}$	Efficiency of the cooler/freezer compressor (kW/Ton)
COP	Coefficient of performance, ratio of output energy/input energy
CV	Constant volume
CW	Condenser water
CWP	Condenser water pump
$Cycles_{annual}$	Number of dryer cycles per year
D	Demand
DC	Direct current
DCV	Demand controlled ventilation
DEER	Database for Energy Efficiency Resources, California
DF	Demand diversity factor
DFP	Default functional period
DHW	Domestic hot water
Dia	Diameter
DLC	DesignLights Consortium®
DOAS	Dedicated outdoor air system
DOE 2.2	US DOE building energy simulation, and cost calculation tool
DPS	Department of Public Service, New York State
DSF	Demand savings factor
DX	Direct expansion
ECCC NYC	Energy Conservation Construction Code of New York City
ECCC NYS	Energy Conservation Construction Code of New York State
EC	Electronically commutated
Econ	Economizer
Ecotope	Ecotope Consulting, Redlands, CA
ee	Energy efficient condition or measure
EEPS	Energy Efficiency Portfolio Standard
EER	Energy efficiency ratio under peak conditions
EF	Energy factor
Eff	Efficiency
E_c	Combustion efficiency
Efficiency Vermont	State of Vermont Energy and Efficiency Initiatives

E_t	Thermal efficiency
EFLH	Equivalent full-load hours
EIA	Energy Information Administration, US
EISA	Energy Independence and Security Act (EISA) of 2007
ElecSF	Electric Savings Factor
ENERGY STAR®	U.S. Environmental Protection Agency voluntary program
Energy Trust	Energy Trust of Oregon, Inc.
EPA	Environmental Protection Agency (EPA), US
EPACT	Energy Policy and Conservation Act of 2005
EPDM	Ethylene propylene diene monomer roofing membrane
ERV	Energy recovery ventilation
ESF	Energy savings factor
EUL	Effective useful life
EFan	Evaporator fan
Exh	Exhaust
F	Factor
F_{elec}	Percentage of energy consumed that is derived from electricity
F_{gas}	Percentage of energy consumed that is derived from gas
FEMP	Federal Energy Management Program
FL	Full-load chiller efficiency under peak conditions
FLH	Full-load hours
Flow	Nozzle flow
FPFC	Four pipe fan coil
ft^2	Square foot
GasSF	Gas Savings Factor
GDS	GDS Associates, Marietta, GA
Glazing area	Aperture area of glazing
GPD	Gallons Per Day
GPM	Gallons Per Minute
GSHP	Ground source heat pump
H_v	Heat of vaporization (latent heat), in Btu/lb
$H_2O_{savings}$	Water savings
HDD	Heating degree day - The number of degrees that a day's average temperature is below 65̊ 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, BTU/watt-hour, total heating output (supply heat) in BTU (including electric heat) during the heating season / total electric energy heat pump consumed (in watt-hour)
ht	Height
HVAC	Heating, ventilation, and air conditioning
$HVAC_c$	HVAC interaction factor for annual electric energy consumption
$HVAC_d$	HVAC interaction factor at utility summer peak hour

$HVAC_g$	HVAC interaction factor for annual natural gas consumption
HW	Hot water
IECC	International Energy Conservation Code
IEER	Integrated energy efficiency ratio
IESNA	Illuminating engineering Society of North America
IPLV	Integrated Part-Load Value, a performance characteristic, typically of a chiller capable of capacity modulation.
k	Thermal conductivity
$KBTUh_{in}$	Annual gas input rating
$kBTUh_{out}$	Annual gas output rating
kW	kilowatts
L	Length
LBNL	Lawrence Berkeley National Laboratory
leakage	Estimate of percent of units not installed in service territory
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LF	Load Factor
Load	Average total weight (lbs) of clothes per drying cycle
LPD	Lighting power density
LRAC	Long-run avoided cost
LSAF	Load shape adjustment factor
MEC	Metropolitan Energy Center
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
^oF	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
psia	Atmospheric pressure (lbs per square inch)
psig	Gauge pressure (lbs per square inch)
PSZ	Packaged single zone
PTAC	Package terminal air conditioner
PTHP	Packaged terminal heat pump
Q	Heat
$Q_{reduced}$	Reduced heat
Q_{reject}	Total heat rejection
r	Radius
RA	Return air
RAC	Room air conditioner
RE	Recovery efficiency
RECS	Residential Energy Consumption Survey
RESNET	Residential Energy Services Network
RH	Reduced heat
RLF	Rated load factor
RPM	Revolutions per minute
R-value	A measure of thermal resistance particular to each material
S	Savings
SAPA	State Administrative Procedure Act
SBC	System Benefit Charge
SCFM	Standard cubic feet per minute @ 68 ^{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
standby	Standby Power (watts)
T	Temperature
TAF	Temperature adjustment factor
TEFC	Totally enclosed fan cooled
th	Thickness
therm	Unit of heat
THR	Total heat rejection
$Throttle_{fac}$	Throttle factor
TMY	Typical meteorological year
tons	Tons of air conditioning
tons/unit	Tons of air conditioning per unit, based on nameplate data
TRC	Total Resources Cost
TRM	Technical Resource Manual
UA	Overall heat loss coefficient (BTU/hr-°F)

UEF	Uniform Energy Factor
unit	Measure
units	Number of measures installed under the program
UPC	Uniform Plumbing Code under the International Association of Plumbing and Mechanical Officials
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
U-value	Measure of heat loss in a building element/overall heat transfer co-efficient
V	Volt
v	Volume
VAV	Variable air volume
VSD	Variable speed drive
W	watts
W_{ctrl}	Total wattage of controlled lighting (watts)
Wisconsin PSC	State of Wisconsin Public Service Commission

Glossary

EQUATION CONVERSION FACTORS	
0.000584	Conversion factor used in DOE test procedure
0.00132	Electric efficient storage type water heater replacing standard storage tank water heater. NAECA referenced as function of storage volume.
0.0019	Natural gas efficient storage type water heater replacing standard storage tank water heater. NAECA referenced as function of storage volume.
0.284	Conversion factor, one kW equals 0.284345 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°F × 60 min/hr
1.6	Typical refrigeration system kW/ton
3.412	Conversion factor, one watt-hour equals 3.412142 BTU
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
100	Conversion factor, one therm equals 100 kBTU
274	Days in non-winter months.
365	Days in one year
3,412	Conversion factor, one kWh equals 3,412 BTU
8,760	Hours in one year
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
6-17-17	6/30/2017
9-17-12	9/30/2017
12-17-18	12/31/2017

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