Paul A. Colbert
Associate General Counsel
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September 29, 2017

VIA ELECTRONIC DELIVERY

Honorable Kathleen H. Burgess
Secretary to the Commission
New York State Public Service Commission
Three Empire State Plaza, 19th Floor
Albany, New York 12223-1350

RE: Case 14-M-0101 – Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision

Case 15-M-0252 – In the Matter of Utility Energy Efficiency Programs

Matter 15-01319 – In the Matter of the New York State Technical Resource Manual New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures

2017 3rd Quarter Update

Dear Secretary Burgess:

In accordance with the requirements set forth in the Order Adopting Regulatory Policy Framework and Implementation Plan issued by the Commission on February 26, 2015 in Case 14-M-0101, Central Hudson Gas and Electric Corporation, Niagara Mohawk Power Corporation d/b/a National Grid, The Brooklyn Union Gas Company d/b/a National Grid NY and KeySpan Gas East Corporation d/b/a National Grid (collectively "National Grid"), Consolidated Edison Company of New York, Inc., National Fuel Gas Distribution Corporation, New York State Electric & Gas Corporation, Orange and Rockland Utilities, Inc., and Rochester Gas and Electric Corporation (collectively the "Joint Utilities") assumed responsibility for maintaining the New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs– Residential, Multi-Family, and Commercial/Industrial Measures ("NY TRM") on June 1, 2015.[1]

[1] Long Island Electric Utility Servco LLC as agent of and acting on behalf of Long Island Lighting Company d/b/a LIPA ("LIPA") was added to the TRM Management Committee in 2016.

The NY TRM Management Committee ("NY TRM MC") has reviewed and approved the ten (10) measures, Appendix P, and Glossary updates attached hereto, all with an effective date of January 1, 2018. Also attached is an updated copy of the detailed work plan, a representative sample of which was included in Appendix B of the TRM Management Plan, filed on September 26, 2017 in Matter 15-01319. The detailed work plan included in this filing provides: (1) a list of the measures reviewed by the TRM MC during the July 2017 through September 2017 period, (2) effective dates of the measures approved in this filing, and (3) a listing of measures currently anticipated to be reviewed during the fourth quarter of calendar 2017.

It should be noted that if a measure or technology is revised or added to the NY TRM, it does not mean that such measure or technology is expressly supported or endorsed by the member companies of the TRM MC. In addition, it should be noted that there is no guarantee that measures or technologies included in the TRM will be offered by utility energy efficiency programs prospectively.

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Respectfully submitted,

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Associate General Council
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Enc.

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Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
9-17-1	R	9/30/2017	1/1/2018	R/MF - Thermostat – Wi-Fi (Communicating)	Updated measure description. Adjusted measure format to align with rest of TRM. Updated deemed savings. Updated EUL reference	Pg. 143
9-17-2	R	9/30/2017	1/1/2018	R/MF - Light Emitting Diode (LED), Compact Fluorescent Lamp (CFL) and Other Lighting	Removed leakage and in service rate gross-to-net adjustment factors. Included EISA update reference.	Pg. 149
9-17-3	R	9/30/2017	1/1/2018	C/I - Chiller – Air and Water Cooled	Updated measure description. Updated kW/ton term. Removed IPLV equation. Updated baseline section to align with current code. Updated EUL Reference.	Pg. 220
9-17-4	R	9/30/2017	1/1/2018	C/I - Thermostat – Wi-Fi (Communicating)	Updated measure description. Adjusted measure format to align with rest of TRM. Updated deemed savings. Updated EUL reference	Pg. 253
9-17-5	R	9/30/2017	1/1/2018	C/I - Interior and Exterior Lamps and Fixtures	Removed in-service rate adjustment factor. Added code LPD discussion.	p. 258
9-17-6	R	9/30/2017	1/1/2018	C/I - Refrigerated Case LED	Updated Measure Description. Updated format of equations and terms to be consistent with TRM. Updated coincidence factor. Updated EUL reference. Revised and annotated default values and references.	Pg. 264

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
9-17-7	R	9/30/2017	1/1/2018	C/I - Interior Lighting Control	Updated Measure Description. Updated format of equations and terms to be consistent with TRM. Updated operating hour section. Updated Ancillary savings sections. Revised write-up for clarity.	Pg. 267
9-17-8	R	9/30/2017	1/1/2018	C/I - Variable Frequency Drive – Fan and Pump	Updated measure description. Clarified equation term definitions, variables and data sources. Updated narrative throughout for clarity. Updated EUL reference	Pg. 277
9-17-9	R	9/30/2017	1/1/2018	C/I - Fan Motor – with Electronically Commutated (EC) Motor, for Refrigerated Case or Walk-In Cooler	Updated Measure Description. Added peak coincident demand savings calculations. Updated format of equations and terms to be consistent with TRM. Added baseline and compliance efficiencies sections. Updated EUL reference. Revised and annotated default values and references.	Pg. 285
9-17-10	R	9/30/2017	1/1/2018	C/I - Anti-Condensation Heater Control	Updated measure description. Consolidated and clarified equation term definitions, variables and data sources. Updated narrative throughout for clarity. Updated EUL reference	Pg. 297
9-17-11	R	9/30/2017	1/1/2018	Appendix P	Updated EUL entries for all measures contained in this Record of Revision	Pg. 577
9-17-12	R	9/30/2017	1/1/2018	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 July 1, 2017 – September 30, 2017.

THERMOSTAT – WI-FI (COMMUNICATING)

Measure Description

This section covers Wi-Fi communicating thermostats without behavioral learning capability applied to single-family and multi-family residential air conditioners, heat pumps, boilers, furnaces and electric resistance baseboard heating systems. These communicating thermostats allow set point adjustment via a remote application. This measure does not apply to Wi-Fi thermostats installed as part of a Demand Response program.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings (Cooling)

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = units \times therms/unit$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
kWh/unit	= Annual electric savings per unit
kW/unit	= Peak coincident demand savings per unit
therms/unit	= Annual gas savings per unit

Summary of Variables and Data Sources

Variable	Value	Notes
kWh/unit	104	Annual electric savings per installed thermostat, in kWh[1]
kW/unit	0.23	Peak demand savings per installed thermostat, in kW[2]
therms/unit	66	Annual gas savings per installed thermostat, in therms[3]

Coincidence Factor (CF)

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

[1] Cadmus Group, Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation, September 2012
[2] Ibid.
[3] Ibid.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency is an HVAC system using natural gas and electricity to provide space heating and cooling controlled by a non-Wi-Fi communicating programmable thermostat.

Compliance Efficiency from which Incentives are Calculated

The compliance efficiency is an HVAC system using natural gas and electricity to provide space heating and cooling controlled by a Wi-Fi communicating thermostat without behavioral learning capability. The thermostat shall not be installed as part of a Demand Response program.

Operating Hours

HVAC system operating hours are embedded in the deemed savings values associated with Wi-Fi communicating thermostats, which are based on metering results.

Effective Useful Life (EUL)

Years: 11
Source: DEER 2014[4]

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. Cadmus Group, Inc. *"Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation"*, prepared for The Electric and Gas Program Administrators of Massachusetts, September 2012
   Available from: http://ma-eeac.org/wordpress/wp-content/uploads/Wi-Fi-Programmable-Controllable-Thermostat-Pilot-Program-Evaluation_Part-of-the-Massachusetts-2011-Residential-Retrofit-Low-Income-Program-Area-Study.pdf
2. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-05-2014; EUL ID: HV-ProgTStat.
   Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

[4] CA DEER – 2014 Updated EUL Records

Record of Revision

Record of Revision Number	Issue Date
1-16-19	12/31/2015
9-17-1	9/30/2017

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LIGHTING

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

Measure Description

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

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

Per EISA 2007, effective beginning January 1, 2020, if more stringent regulations are not put into effect by that date, the sale of general service lamps that do not meet a minimum efficiency standard of 45 lumens per watt will be prohibited.[2] As a result of this stipulation, deemed baseline wattages for non-exempt general service lighting will be reduced to reflect this requirement in the January 2020 NY TRM. This will have significant impact on claimable savings associated with replacement of general service lamps (20 – 70% depending on lumen output). This information is provided to inform future ETIP development.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

[1] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 86
[2] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 89

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
W	= Rated wattage of lamp and/or fixture (Watts)
$_{baseline}$	= Baseline condition or measure
$_{ee}$	= Energy efficient condition or measure
1,000	= Conversion factor, one kW equals 1,000 Watts
CF	= Coincidence factor
$hrs_{operating}$	= Lighting operating hours
$HVAC_c$	= HVAC interaction factor for annual electric energy consumption
$HVAC_d$	= HVAC interaction factor for peak demand at NYISO coincident summer peak hour
$HVAC_g$	= HVAC interaction factor for annual natural gas consumption (therms/kWh)

Summary of Variables and Data Sources

Variable	Value	Notes
units		Number of lamps sold/distributed under the program, from application
W_{ee}		Energy efficient measure Watts, from application
$W_{baseline}$		Baseline measure Watts, from application or default values from applicable table in "Baseline Efficiencies…" section below
$hrs_{operating}$	1,168 - Interior Lamps 913 - Interior Fixtures 1,643 - Exterior	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.
$HVAC_c$	0 for Exterior and Unconditioned Spaces	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	0 for Exterior and Unconditioned Space	HVAC interaction factor for peak demand at utility summer peak hour (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_g$	0 for Exterior and Unconditioned Space	HVAC interaction factor for annual natural gas energy consumption (therms/kWh). Vintage and HVAC type weighted average by city. See Appendix D.
CF	0.082 – Interior 0.0 – Exterior	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

HVAC system interaction factors are defined as the ratios of the cooling energy and demand reduction and heating energy increase per unit of lighting energy reduction. Much of the input energy for lighting systems is converted to heat that must be removed by the HVAC system. Reductions in lighting heat gains due to lighting power reduction decrease the need for space cooling and increase the need for space heating.

HVAC interaction factors vary by climate, HVAC system type and building type. Recommended values for HVAC interaction factors for lighting energy and peak demand savings are shown in Appendix D. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0.

Coincidence Factor (CF)

The recommended value for the coincidence factor for interior lighting is 0.082. This factor was derived from an examination of studies throughout New England that calculated coincidence factors based on the definition of system peak period at the time, as specified by ISO-New England.[3]

Because exterior lighting is assumed to operate during off-peak hours only, the recommended coincidence factor for exterior lighting is 0.0.

Baseline Efficiencies from which Savings are Calculated

Rated wattage baseline values should reflect the guidance noted below based on bulb type and lumens in accordance with EISA standards. Note that deemed baseline wattages for non-exempt general service lighting will be reduced to reflect the EISA 2007 "Backstop Requirement" beginning with the January 2020 NY TRM, assuming more stringent requirements are not established.. This requirement, prohibiting the sale of general service lamps that do not meet a minimum efficiency standard of 45 lumens per watt will have significant impact on claimable savings associated with replacement of general service lamps (20 – 70% depending on lumen output). [4]

General Service Lamps

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

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

Certain lamp types are exempt from EISA compliance, including reflector lamps (see Reflector/Flood Lamps section below), decorative and globe shape lamps (see Specialty Lamps section below) and three-way lamps. Baseline wattage for any of these exempt lamp types should

[3] Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, Spring 2007, Table i-1
[4] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 89

reflect the values in column (c) of the table below, with the exception of those lamps defined in the Specialty Lamps or Reflector/Flood Lamps sections below. All other general service lamps should use the baseline wattage values in column (b), corresponding to the applicable lumen range identified in column (a). For standard lamps that fall outside of the prescribed lumen ranges below, the manufacturer recommended baseline wattage should be used. For a complete list and definitions of EISA-exempt lamp types, reference Sec. 321: Efficient Light Bulbs of Public Law 110-140.[5]

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

Specialty Lamps[6]

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

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

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

[6] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 21: Residential Lighting Evaluation Protocol, National Renewable Energy Laboratory, December 2014, p. 8-11

Reflector/Flood Lamps[7]

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

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

Compliance Efficiency from which Incentives are Calculated

Compliance efficiency and fixture/lamp specifications shall be dictated by program eligibility criteria.

Operating Hours

Lamps

Hours of operation for lamps are estimated to be 3.2 operating hours per day or 1,168 (3.2 x 365) hours per year. The 3.2 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island, and Vermont . The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day, based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 4.8 hours from the markdown program component and 3.2 from the coupon program component. This value represents a trade-off among factors that may affect the extent to which any out-of New York State value is applicable to NY. These include such factors as differences between the study area and NY, related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 3.2 appears to be the most reasonable prior to New York-specific impact studies. This value is appropriate for interior applications only. For exterior

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

applications, assume a total of 1,643 hours which is based on updated results from the 2003 Nexus Market Research .

Fixtures

Hours of operation for fixtures are estimated to be 2.5 operating hours per day or 913 (2.5 x 365) hours per year. The 2.5 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island and Vermont2. The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day, based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 2.4 for interior fixtures3. The proposed value represents a trade-off among factors that may affect the extent to which any value from outside of New York State is applicable to NY. These include such factors as differences between the study area and NY related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 2.5 appears to be the most reasonable prior to New York specific impact studies.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

References

1. Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 82-86
   Available from: https://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf
2. Impact evaluations of residential lighting programs in several New England states reviewed in preparing the proposed hours-of-use values and coincidence factors include:
   a. Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs, prepared for Cape Light Compact, Vermont Public Service Department, National Grid Massachusetts and Rhode Island, Western Massachusetts Electric Company, NSTAR Electric, Fitchburg G&E by Nexus Market Research Inc., and RLW Analytics Inc., Oct 1, 2004.
      Available from: https://library.cee1.org/system/files/library/1308/485.pdf
   b. Extended Residential Logging Results memo to Angela Li, National Grid, by Tom Ledyard, RLW Analytics Inc., and Lynn Hoefgen, Nexus Market Research Inc., May 2, 2005

c. Market Progress and Evaluation Report for the 2005 Massachusetts ENERGY STAR Lighting Program, prepared for Cape Light Compact, National Grid – Massachusetts, NSTAR, Western Massachusetts Electric Company by Nexus Market Research Inc, RLW Analytics, Inc., Shel Feldman Management Company, Dorothy Conant. September 29, 2006.
Available from: https://library.cee1.org/system/files/library/1297/474.pdf
d. Process and Impact Evaluation of the Efficiency Maine Lighting Program, prepared for Efficiency Maine by Nexus Market Research Inc. and RLW Analytics Inc., April 10, 2007.
Available from: https://library.cee1.org/system/files/library/1386/564.pdf
3. Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures - For use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM), prepared for the New England State Program Working Group by RLW Analytics Inc., Spring 2007.
Available from: https://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/116_RLW_CF%20Res%20C&I%20ltg.pdf
4. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 21: Residential Lighting Evaluation Protocol, National Renewable Energy Laboratory, December 2014, p. 8-11.
Available from: http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf
5. State of Pennsylvania Technical Reference Manual, PA Public Utilities Commission, June 2016, p. 21-22
Available from: http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
7-13-2	7/31/2013
6-15-3	6/1/2015
1-16-3	12/31/2015
1-17-4	12/31/2016
9-17-2	9/30/2017

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CHILLER – AIR AND WATER COOLED

Measure Description

This measure applies to constant and variable speed electric air-cooled and water-cooled chillers in commercial buildings with built-up HVAC systems.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times tons/unit \times (IPLV_{baseline} - IPLV_{ee}) \times EFLH_{cooling}$$

Peak Coincident Demand Savings

$$\Delta kW = units \times tons/unit \times (FL_{baseline} - FL_{ee}) \times CF$$

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 nameplate data
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure
IPLV	= Integrated part-load value (in kW/Ton)
FL	= Full-load chiller efficiency under peak conditions
EFLH	= Equivalent full-load hours
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application
$FL_{baseline}$		Full-load efficiency of baseline chiller under peak conditions, lookup based on chiller type and size from Baseline Efficiencies tables below. Use Path A values for constant speed chillers and Path B values for variable speed chillers (based on proposed case).
FL_{ee}		Full-load efficiency of energy efficiency chiller, from application.

Variable	Value	Notes
$IPLV_{baseline}$		Integrated part-load value (kW/ton) of baseline chiller, lookup based on chiller type and size from Baseline Efficiencies tables below. Use Path A values for constant speed chillers and Path B values for variable speed chillers (based on proposed case).
$IPLV_{ee}$		Integrated part-load value (kW/ton) for energy efficient measure, from application.
3.517		Conversion factor, one ton equals 3.516853 kilowatts.
$EFLH_{cooling}$		Cooling equivalent full-load hours, lookup by city, building type and HVAC type from Appendix G.
CF	0.8	

The rated full-load kW/ton (***FL***) at AHRI rating conditions is used to define the efficiency under peak conditions. The ***IPLV*** as defined by AHRI is used to define the annual average efficiency. Note, chiller full-load efficiency or IPLV may also be expressed as coefficient of performance (COP). To convert chiller efficiency from COP to kW/ton, use the following equation: kW/ton = 3.517 / COP.

Coincidence Factor (CF)

Recommended value for the coincidence factor is 0.8.[1]

Baseline Efficiencies from which Savings are Calculated

The baseline full load and IPLV kW/Ton values listed in the tables below, per the 2016 Energy Conservation Construction Code of New York State[2] and 2016 New York City Energy Conservation Code[3], shall be used. Path A values shall be used for proposed constant speed chillers and Path B values for proposed variable speed chillers.

[1] *No source specified – update pending availability and review of applicable references.*
[2] ECCCNYS 2016, Table C403.2.3(7)
[3] NYCECC 2016; Table C403.2.3(7)

Path A – Constant Speed Chillers

Equipment Type	Size Category	ECCCNYS Maximum Full Load (kW/Ton)	ECCCNYS Maximum IPLV (kW/Ton)	NYCECC Maximum Full Load (kW/Ton)	NYCECC Maximum IPLV (kW/Ton)
Air-Cooled Chillers	< 150 Tons	1.188	0.876	1.188	0.876
	≥ 150 Tons	1.188	0.857	1.188	0.857
Water-Cooled, Positive Displacement	< 75 Tons	0.750	0.600	0.750	0.600
	≥ 75 Tons and < 150 Tons	0.720	0.560	0.720	0.560
	≥ 150 Tons and < 300 Tons	0.660	0.540	0.660	0.540
	≥ 300 Tons and < 600 Tons	0.610	0.520	0.610	0.520
	≥ 600 Tons	0.560	0.500	0.560	0.500
Water Cooled, Centrifugal	< 150 Tons	0.610	0.550	0.610	0.550
	≥ 150 Tons and < 300 Tons	0.610	0.550	0.610	0.550
	≥ 300 Tons and < 400 Tons	0.560	0.520	0.560	0.520
	≥ 400 Tons and < 600 Tons	0.560	0.500	0.560	0.500
	≥ 600 Tons	0.560	0.500	0.560	0.500

Path B – Variable Speed Chillers

Equipment Type	Size Category	ECCCNYS Maximum Full Load (kW/Ton)	ECCCNYS Maximum IPLV (kW/Ton)	NYCECC Maximum Full Load (kW/Ton)	NYCECC Maximum IPLV (kW/Ton)
Air-Cooled Chillers	< 150 Tons	1.237	0.759	1.237	0.759
	≥ 150 Tons	1.237	0.745	1.237	0.745
Water-Cooled, Positive Displacement	< 75 Tons	0.780	0.500	0.780	0.500
	≥ 75 Tons and < 150 Tons	0.750	0.490	0.750	0.490
	≥ 150 Tons and < 300 Tons	0.680	0.440	0.680	0.440
	≥ 300 Tons and < 600 Tons	0.625	0.410	0.625	0.410
	≥ 600 Tons	0.585	0.380	0.585	0.380

Equipment Type	Size Category	ECCCNYS Maximum Full Load (kW/Ton)	ECCCNYS Maximum IPLV (kW/Ton)	NYCECC Maximum Full Load (kW/Ton)	NYCECC Maximum IPLV (kW/Ton)
Water Cooled, Centrifugal	< 150 Tons	0.695	0.440	0.695	0.440
	≥ 150 Tons and < 300 Tons	0.635	0.400	0.635	0.400
	≥ 300 Tons and < 400 Tons	0.595	0.390	0.595	0.390
	≥ 400 Tons and < 600 Tons	0.585	0.380	0.585	0.380
	≥ 600 Tons	0.585	0.380	0.585	0.380

Compliance Efficiency from which Incentives are Calculated

Compliance efficiency requirements shall be dictated by program eligibility criteria.

Operating Hours

Cooling equivalent full-load hours (EFLH) were calculated from a DOE-2.2 simulation of prototypical large office building. The prototype building characteristics are described in Appendix A. The $EFLH_{cooling}$ for built-up HVAC systems in commercial buildings by climate zone and building type are shown in Appendix G.

Effective Useful Life (EUL)

Years: 20
Source: DEER 2014[4]

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. ECCCNYS 2016, per IECC 2015; Table C403.2.3(7): Water Chilling Packages – Efficiency Requirements
   Available from: https://codes.iccsafe.org/public/document/code/444/7965605

[4] CA DEER – 2014 Updated EUL Records

2. NYCECC 2016; Table C403.2.3(7): Water Chilling Packages – Efficiency Requirements Available from: https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHC4.pdf&section=energy_code_2016
3. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-05-2014; EUL ID: HVAC-Chlr. Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

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1	10/15/2010
9-17-3	9/30/2017

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THERMOSTAT – WI-FI (COMMUNICATING)

Measure Description

This section covers Wi-Fi communicating thermostats without behavioral learning capability applied to small commercial buildings with natural gas heat boilers or furnaces, electric heat pumps, electric resistance heating or central air conditioners. These communicating thermostats allow set point adjustment via a remote application. This measure does not apply to Wi-Fi thermostats installed as part of a Demand Response program.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings (Cooling)

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

$$\Delta therms = units \times therms/unit$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
kWh/unit	= Annual electric savings per unit
kW/unit	= Peak coincident demand savings per unit
therms/unit	= Annual gas savings per unit

Summary of Variables and Data Sources

Variable	Value	Notes
kWh/unit	104	Annual electric savings per installed thermostat, in kWh[1]
kW/unit	0.23	Peak demand savings per installed thermostat, in kW[2]
therms/unit	66	Annual gas savings per installed thermostat, in therms[3]

Coincidence Factor (CF)

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

[1] Cadmus Group, Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation, September 2012
[2] Ibid.
[3] Ibid.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency is an HVAC system using natural gas and electricity to provide space heating and cooling controlled by a non-Wi-Fi communicating programmable thermostat.

Compliance Efficiency from which Incentives are Calculated

The compliance efficiency is an HVAC system using natural gas and electricity to provide space heating and cooling controlled by a Wi-Fi communicating thermostat without behavioral learning capability. The thermostat shall not be installed as part of a Demand Response program.

Operating Hours

HVAC system operating hours are embedded in the deemed savings values associated with Wi-Fi communicating thermostats, which are based on metering results.

Effective Useful Life (EUL)

Years: 11
Source: DEER 2014[4]

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. Cadmus Group, Inc. (September 2012), *"Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation"*, prepared for The Electric and Gas Program Administrators of Massachusetts.
   Available from: http://ma-eeac.org/wordpress/wp-content/uploads/Wi-Fi-Programmable-Controllable-Thermostat-Pilot-Program-Evaluation_Part-of-the-Massachusetts-2011-Residential-Retrofit-Low-Income-Program-Area-Study.pdf
2. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-05-2014; EUL ID: HV-ProgTStat.
   Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

[4] CA DEER – 2014 Updated EUL Records

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1-16-5	12/31/2015
9-17-4	9/30/2017

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LIGHTING

INTERIOR AND EXTERIOR LAMPS AND FIXTURES

Measure Description

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

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

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

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

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

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
CF	= Coincidence factor
$_{ee}$	= Energy efficient condition or measure
$_{baseline}$	= Baseline condition or measure
area	= Extent of space or surface
1,000	= Conversion factor, one kW equals 1,000 watts
LPD	= Lighting power density
W	= Watts
$hrs_{operating}$	= Lighting operating hours
$HVAC_c$	= HVAC interaction factor for annual electric energy consumption
$HVAC_d$	= HVAC interaction factor for peak demand at NYISO coincident summer peak hour
$HVAC_g$	= HVAC interaction factor for annual natural gas consumption (therms/kWh)

Summary of Variables and Data Sources

Variable	Value	Notes
$Units_{baseline}$		Number of baseline measures, from application. Set equal to $Units_{ee}$ if unknown.
$Units_{ee}$		Number of energy efficient measures installed under the program, from application.
$W_{baseline}$		Connected load of the baseline unit(s) displaced, from application (in Watts).
W_{ee}		Connected load of the energy-efficient unit, from application (in Watts).
$hrs_{operating}$		Lighting operating hours. From application or default, as listed below in the Operating Hours table.

Variable	Value	Notes
$LPD_{baseline}$		Lighting power density (in W/SF) for baseline measure, from application, based on NYS/NYC Energy Conservation code. New construction or major renovation (as defined by applicable code/permits) only.
LPD_{ee}		Lighting power density (in W/SF) for energy efficient measure, from application, based on installed system design. New construction or major renovation (as defined by applicable code/permits) only.
area		Floor area illuminated by lighting system (in SF)
$HVAC_c$	0 for Exterior and Unconditioned Space	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	0 for Exterior and Unconditioned Space	HVAC interaction factor for peak demand at utility summer peak hour (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_g$	0 for Exterior and Unconditioned Space	HVAC interaction factor for annual natural gas energy consumption (therms/kWh). Vintage and HVAC type weighted average by city. See Appendix D.
CF	1.0 for Interior 0.0 for Exterior	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

HVAC system interaction factors are defined as the ratios of the cooling energy and demand reduction and heating energy increase per unit of lighting energy reduction. Much of the input energy for lighting systems is converted to heat that must be removed by the HVAC system. Reductions in lighting heat gains due to lighting power reduction decrease the need for space cooling and increase the need for space heating.

HVAC interaction factors vary by climate, HVAC system type and building type. Recommended values for HVAC interaction factors for lighting energy and peak demand savings are shown in Appendix D. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0. The building types for the HVAC interactive effect factors by facility type are shown in the lighting Operating Hours table below.

Coincidence Factor (CF)

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

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

Baseline Efficiencies from which Savings are Calculated

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

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

Compliance Efficiency from which Incentives are Calculated

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

Operating Hours

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

Facility Type	Lighting Hours (hrs/yr)	HVAC Int	Facility Type	Lighting Hours (hrs/yr)	HVAC Int
Auto Related[1]	2,810	AR	Manufacturing Facility	2,857	Ind
Automotive / Transportation Service or Repair Facility (24/7)	8,760	AR	Medical Offices	3,748	SOfc
Bakery	2,854	FS	Motion Picture Theatre	1,954	Asy
Banks	3,748	SOfc	Multi-Family (Common Areas)	7,665	MFL
Church	1,955	Rel	Museum	3,748	Asy
College– Cafeteria[2]	2,713	FS	Nursing Homes	5,840	MFL
College – Classes	2,586	CC	Office (General Office Types)[2]	3,013	SOfc/ LOfc

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

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

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

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

References

1. ECCCNYS 2016, per IECC 2015; Chapter C404.4: Interior Lighting Power Requirements (Prescriptive) & C405.5: Exterior Lighting Power (Mandatory)
   Available from: https://codes.iccsafe.org/public/document/code/444/7965605
2. NYCECC 2016: Chapter C404.4: Interior Lighting Power Requirements (Prescriptive) & C405.5: Exterior Lighting Power (Mandatory)
   Available from: https://www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page
3. Lighting operating hour data taken from the CL&P and UI Program Savings Documentation for 2008 Program Year, with exceptions as noted.
   Available from: https://library.cee1.org/system/files/library/8821/CEE_Eval_2008ProgramSavingsDocumentPSD_1Jan2008.pdf
4. Additional lighting operating hour data taken from 2008 DEER Update – Summary of Measure Energy Analysis Revisions, August, 2008
   Available from: www.deerresources.com
5. Small Business Direct Install Program Evaluation Review, Prepared for the New York State Department of Public Service-E^2 Working Group, by the Small Commercial EM&V Review subcommittee, April 3, 2015
   Available from: https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/96006876d01739b785257c85005a58e3/$FILE/ATTGYZRG.pdf/SBDI%20EMV%20studies%20-%20Final%20Report%20-%202015-01-30.pdf

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1	10/15/2010
6-15-4	6/1/2015
1-16-6	12/31/2015
9-17-5	9/30/2017

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REFRIGERATED CASE LED

Measure Description

This measure pertains to installation of horizontally or vertically-mounted LED fixtures in commercial display refrigerators, coolers or freezers. Refrigerated case lighting increases the cooling load of the refrigeration system by adding heat to the unit that must be overcome through additional cooling. Replacing fluorescent lamps with low-heat generating LEDs reduces the energy consumption associated with the lighting components and reduces the amount of waste heat generated from the lamps that must be overcome by the refrigeration system.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \left(\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right) \times hrs_{operating} \times (1 + (Comp_{eff} \times 0.284))$$

Peak Coincident Demand Savings

$$\Delta kW = \left(\frac{(W \times units)_{baseline} - (W \times units)_{ee}}{1{,}000}\right) \times CF \times (1 + (Comp_{Eff} \times 0.284))$$

Annual Gas Energy Savings

$$\Delta therms = N/A$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of measures installed under the program
W	= Rated wattage of lamp or fixture (Watts)
$_{baseline}$	= Baseline condition or measure
$_{ee}$	= Energy efficient condition or measure
1,000	= Conversion factor, one kW equals 1,000 Watts
$hrs_{operating}$	= Lighting operating hours
CF	= Coincidence factor
$Comp_{Eff}$	= Efficiency of the cooler/freezer compressor (kW/Ton)
0.284	= Conversion factor from kW to Tons of refrigeration (Tons/kW)

Summary of Variables and Data Sources

Variable	Value	Notes
$W_{baseline}$		From application, or 2 times the proposed LED wattage[1]
W_{ee}		From application
$hrs_{operating}$		From application
$Comp_{Eff}$	Refrigerated Case – 1.00 Freezer Case - 1.92	Typical refrigeration system efficiency (kW/Ton)[2]
CF	0.948	Taken from RLW Analytics, Inc. Coincidence Factor study, "Grocery" facility type

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.948.[3]

Baseline Efficiencies from which Savings are Calculated

The baseline lighting wattage is the rated or deemed wattage of the existing fixture/lamp. See table of standard fixture wattages in Appendix C. If this data is not available, the baseline wattage shall be the proposed wattage multiplied by 2.

Compliance Efficiency from which Incentives are Calculated

The compliance case is a refrigerated display case with horizontally or vertically-mounted LED lighting. Compliance efficiency and fixture/lamp specifications shall be dictated by program eligibility criteria.

Operating Hours

Operating hours for refrigerated case lighting will be site-specific and taken from the application. If unavailable, refer to the "Operating Hours" section of the Commercial and Industrial Interior and Exterior Lamps and Fixtures measure for default hours of operation.

Effective Useful Life (EUL)

Years: 16
Source: DEER 2014[4]

[1] *REVIEW OF UNDERLYING REFERENCE PENDING:* Based on Pacific Gas & Electric. May 2007. LED Refrigeration Case Lighting Workpaper 053007 rev1. This workpaper is not publicly available, but is referenced by Mid-Atlantic TRM Version 7.0 published May 2017. Assumes LED case lighting (7.6W per linear foot) replacing T8 fluorescent baseline (15.2W per linear foot).
[2] Based on CDH Energy evaluation of actual refrigeration system performance for several commercially available compressors, dated 09/06/2017. Values presented reflect average efficiencies of R22 systems.
[3] Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Inc. Spring 2007, Table i-7 (Grocery)
[4] CA DEER – 2014 Updated EUL Records

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

Reduction in refrigerated case lighting power reduces waste heat that must be displaced by the system. Interactive effects are addressed in the prescribed energy savings calculation methodology.

References

1. Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures - For use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM), prepared for the New England State Program Working Group by RLW Analytics Inc., Spring 2007.
   Available
   from: https://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/116_RLW_CF%20Res%20C&I%20ltg.pdf
2. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-05-2014; EUL ID: GrocDisp-FixtLtg-LED. Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

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0	10/15/2010
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INTERIOR LIGHTING CONTROL

Measure Description

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

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

Annual Gas Energy Savings

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

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
W_{ctrl}	= Total wattage of controlled lighting (Watts)
1,000	= Conversion factor, one kW equals 1,000 Watts
$hrs_{operating}$	= Lighting operating hours
$_{baseline}$	= Baseline condition or measure
$HVAC_c$	= HVAC interaction factor for annual electric energy consumption
$HVAC_d$	= HVAC interaction factor for peak demand at NYISO coincident summer peak hour
$HVAC_g$	= HVAC interaction factor for annual natural gas consumption (therms/kWh)
ESF	= Energy savings factor
CF	= Coincidence factor

Summary of Variables and Data Sources

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

Energy Savings Factor[1]

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

Control Type	ESF
Occupancy Sensor	0.30
Daylight Dimming Control	0.30
Daylight Stepped Control	0.20
Programmable Control	0.15

- ***Occupancy Sensor*** – Reduces lighting operating hours by switching off lighting in unoccupied spaces.
- ***Daylight Dimming Control*** – Reduces lighting output to a set level in response to natural daylighting using continuous dimming capability.
- ***Daylight Stepped Control*** – Reduces lighting output to a set level in response to natural daylighting using stepped dimming capability.
- ***Programmable Control*** – Sophisticated lighting controllers that combine many of the above functions into a single unit and may also be coupled to the building security system.

[1] *REVIEW OF UNDERLYING REFERENCE PENDING:* ESF values derived from lighting control power adjustment factors prescribed in the California Title 24 Nonresidential Lighting Standards.

Coincidence Factor (CF)

The recommended coincidence factor for commercial indoor lighting measures is 1.0.[2]

Baseline Efficiencies from which Savings are Calculated

The baseline case for this measure is a lighting system with manual or time-switch controls. This measure is not applicable in spaces for which occupancy or daylight-responsive controls are required by federal, state or local code. Refer to chapter C405.2 Lighting Controls (Mandatory) of the Energy Conservation Construction Code of New York State[3] (ECCCNYS) and the New York City Energy Conservation Code[4] (NYCECC) for details.

Compliance Efficiency from which Incentives are Calculated

The compliance case is a lighting system with occupancy or daylight-responsive controls designed and installed in accordance with manufacturers' and/or designer recommendations. Compliance specifications shall be dictated by program eligibility criteria.

Operating Hours

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

Effective Useful Life (EUL)

Years: 8
Source: DEER 2014[5]

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts are addressed in the prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts are addressed in the prescribed energy savings calculation methodology.

[2] *No source specified – update pending availability and review of applicable references.*
[3] ECCCNYS 2016; C405.2: Lighting Controls (Mandatory)
[4] NYCECC 2016; C405.2: Lighting Controls (Mandatory)
[5] CA DEER – 2014 Updated EUL Records.

References

1. ECCCNYS 2016, per IECC 2015; Chapter C405.2: Lighting Controls (Mandatory)
   Available from: https://codes.iccsafe.org/public/document/code/444/7965605
2. NYCECC 2016: Chapter C405.2: Lighting Controls (Mandatory)
   Available from: https://www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page
3. Energy Savings Factors derived from lighting control power adjustment factors prescribed in the California Title 24 Nonresidential Lighting Standards.
4. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-07-2014; EUL IDs: GlazDayIT-Dayltg, ILtg-OccSens.
   Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

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Record of Revision Number	Issue Date
1	10/15/2010
6-15-4	6/1/2015
1-16-7	12/31/2015
9-17-7	9/30/2017

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VARIABLE FREQUENCY DRIVE – FAN AND PUMP

Measure Description

This measure addresses variable frequency drives applied to fans and pumps in commercial and industrial buildings. Applications covered in this section are; AHU supply and return fans, CHW pumps, cooling tower fans, condenser water pumps and heating hot water pumps.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

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

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	= Horsepower
(ΔkWh/hp)	= Annual electric energy savings (in kWh) per controlled motor horsepower
(ΔkW/hp)	= Electric demand savings (in kW) per controlled motor horsepower
CF	= Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
hp		Horsepower rating of motor controlled by VFD, from application
(ΔkW/hp)		Electric demand savings from VFD per horsepower of motor controlled. Lookup in Appendix K by building type and VFD application. If no deemed savings are specified, (ΔkW/hp) = 0.
(ΔkWh/hp)		Annual energy savings from VFD per horsepower of motor controlled. Lookup in Appendix K by building type, city and VFD application.
CF	0.8	

Coincidence Factor (CF)

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

Baseline Efficiencies from which Savings are Calculated

The baseline system characteristics by application are as follows:

- Chilled water and hot water pumps:
  - Variable volume, constant speed secondary pumping system
    - Existing pump rides pump curve as flow varies
- Supply fans:
  - VAV system with inlet vane control
- Return fans:
  - VAV system with discharge damper control
- Cooling tower fans:
  - One speed constant volume fan
- Condenser water pumps:
  - Constant speed, constant flow condenser water pumps

Compliance Efficiency from which Incentives are Calculated

The compliance system characteristics by application are as follows:

- Chilled water and hot water pumps:
  - Variable volume, variable speed secondary pumping system
- Supply fans:
  - VAV system with VFD control
- Return fans:
  - VAV system with VFD control
- Cooling tower fans:
  - Variable speed fans controlling condenser water temperature to 85°F
- Condenser water pumps:
  - Variable speed, variable flow condenser water loop

Operating Hours

The annual energy savings from VFD per horsepower of motor controlled (ΔkWh/hp) defined in Appendix K incorporate operating hours consideration.

Effective Useful Life (EUL)

Years: 15
Source: DEER 2014[2]

[1] *No source specified – update pending availability and review of applicable references.*
[2] CA DEER – 2014 Updated EUL Records.

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

N/A

References

1. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-07-2014; EUL IDs: HVAC-VSD-fan and HVAC-VSDSupFan.
   Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
7-13-12	7/31/2013
9-17-8	9/30/2017

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FAN MOTOR – WITH ELECTRONICALLY COMMUTATED (EC) MOTOR, FOR REFRIGERATED CASE OR WALK-IN COOLER

Measure Description

This measure covers replacement of shaded pole or permanent split evaporator fan motors with electronically commutated (EC) motors in walk-in and reach-in refrigerated cases. These high-efficiency motors achieve savings by reducing evaporator fan power and through interactive effects with the system's compressor. EC motors introduce less waste heat into the refrigerated case, reducing the total cooling load.

Method for Calculating Annual Energy and Peak Coincident Demand Savings for Walk-In Coolers/Freezers

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{EFan} + \Delta kWh_{RH}$$

$$\Delta kWh_{EFan} = units \times \left(\frac{A_{EFan} \times V_{EFan} \times \sqrt{Phase_{EFan}}}{1{,}000}\right) \times F_{PA} \times F_{EFan} \times hrs_{EFan}$$

$$\Delta kWh_{RH} = \Delta kWh_{EFan} \times Comp_{Eff} \times 0.284$$

Peak Coincident Demand Savings

$$\Delta kW = \Delta kW_{EFan} + \Delta kW_{RH}$$

$$\Delta kW_{EFan} = units \times \left(\frac{A_{EFan} \times V_{EFan} \times \sqrt{Phase_{EFan}}}{1{,}000}\right) \times F_{PA} \times F_{EFan} \times CF$$

$$\Delta kW_{RH} = \Delta kW_{EFan} \times Comp_{Eff} \times 0.284$$

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
ΔkWh_{EFan}	= Annual electric savings due to evaporator fan motor replacement
ΔkWh_{RH}	= Annual electric savings due to reduced heat from evaporator fan motor replacement
ΔkW_{EFan}	= Peak coincident demand savings due to evaporator fan motor replacement
ΔkW_{RH}	= Peak coincident demand savings due to reduced heat from evaporator fan motor replacement

units = Number of measures installed under the program
A_{EFan} = Nameplate amperage of existing evaporator fan motor
V_{EFan} = Nameplate voltage of existing evaporator fan motor
$Phase_{EFan}$ = Phase of existing evaporator fan
1,000 = Conversion factor, one kW equals 1,000 W
F_{PA} = Power adjustment factor
F_{EFan} = Reduction of load by replacing evaporator fan motor
hrs_{EFan} = Evaporator fan annual operating hours
$Comp_{Eff}$ = Efficiency of the cooler/freezer compressor (kW/Ton)
0.284 = Conversion factor from kW to Tons of refrigeration (Tons/kW)
CF = Coincidence factor

Method for Calculating Annual Energy and Peak Coincident Demand Savings for Refrigerated Cases

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{CM} + \Delta kWh_{RH}$$

$$\Delta kWh_{CM} = units \times kVA_{CM} \times F_{CM} \times hrs_{CM}$$

$$\Delta kWh_{RH} = \Delta kWh_{CM} \times Comp_{Eff} \times 0.284$$

Peak Coincident Demand Savings

$$\Delta kW = \Delta kW_{CM} + \Delta kW_{RH}$$

$$\Delta kW_{CM} = units \times kVA_{CM} \times F_{CM} \times CF$$

$$\Delta kW_{RH} = \Delta kW_{CM} \times Comp_{Eff} \times 0.284$$

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
ΔkWh_{CM} = Annual electric savings due to case motor replacement
ΔkWh_{RH} = Annual electric savings due to reduced heat from case motor replacement
ΔkW_{CM} = Peak coincident demand savings due to case motor replacement
ΔkW_{RH} = Peak coincident demand savings due to reduced heat from case motor replacement
units = Number of measures installed under the program
kVA_{CM} = Metered load of existing case motor

F_{CM} = Reduction of load by replacing case motor
hrs_{CM} = Case motor annual operating hours
$Comp_{Eff}$ = Efficiency of the cooler/freezer compressor (kW/Ton)
0.284 = Conversion factor from kW to Tons of refrigeration (Tons/kW)
CF = Coincidence factor

Summary of Variables and Data Sources

Variable	Value	Notes
A_{EFan}		From application
V_{EFan}		From application
$Phase_{EFan}$		From application
F_{PA}	0.55	Based on experience of National Resource Management (NRM) [1]
hrs_{EF}	Cooler Control – 5,600 No Cooler Control - 8,760	Based on experience of NRM[2]
hrs_{CM}	8,500	Based on experience of NRM[3]
F_{EFan}	0.65	Based on numerous pre and post meter readings conducted by NRM and supported by RLW Analytics evaluation.[4]
F_{CM}	Shaded Pole – 0.53 PSC – 0.29	If a shaded pole motor is being replaced, use 0.53. If a PSC motor is being replaced, use 0.29. Based on numerous pre and post meter readings conducted by NRM.[5]
$Comp_{Eff}$	Refrigerated Case – 1.00 Freezer Case - 1.92	Typical refrigeration system efficiency (kW/Ton)[6]
CF	1.0	

Coincidence Factor (CF)

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

Baseline Efficiencies from which Savings are Calculated

The baseline case is a walk-in cooler/freezer or refrigerated display case with shaded pole or permanent split capacitor (PSC) evaporator fan motors.

[1] *REVIEW OF UNDERLYING REFERENCE PENDING:* Cooler Control Measure Impact Spreadsheet User's Manual, Select Energy Services, Inc., March 2004
[2] Ibid.
[3] Ibid.
[4] Small Business Services, Custom Measure Impact Evaluation, RLW Analytics, Inc., March 2007
[5] *REVIEW OF UNDERLYING REFERENCE PENDING:* Cooler Control Measure Impact Spreadsheet User's Manual, Select Energy Services, Inc., March 2004
[6] Based on CDH Energy evaluation of actual refrigeration system performance for several commercially available compressors, dated 09/06/2017. Values presented reflect average efficiencies of R22 systems.
[7] *No source specified – update pending availability and review of applicable references.*

Compliance Efficiency from which Incentives are Calculated

The compliance case is a walk-in cooler/freezer or refrigerated display case with electronically commutated (EC) evaporator fan motors.

Operating Hours

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

Effective Useful Life (EUL)

Years: 15
Source: DEER 2014[8]

Ancillary Fossil Fuel Savings Impacts

N/A

Ancillary Electric Savings Impacts

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

References

1. *Cooler Control Measure Impact Spreadsheet Users' Manual*, Select Energy Services, Inc. for NSTAR, March 9, 2004
2. Small Business Services, Custom Measure Impact Evaluation, RLW Analytics, Inc. for National Grid, March 23, 2007
   Available from: https://library.cee1.org/system/files/library/8713/CEE_Eval_2007CustomMeasureImpactEvaluation_23Mar2007.pdf
3. Power Factor/Adjustment of 0.55, estimate by National Resource Management, based on their experience over the past 15 years.
4. Percent reduction (0.65) of load by replacing motors, estimate by National Resource Management based on several pre and post meter readings of installations. This is supported by RLW report for National Grid.
5. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-05-2014; EUL ID: GrocDisp-FEvapFanMtr. Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

[8] CA DEER – 2014 Updated EUL Records

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
7-13-17	7/31/2013
9-17-9	9/30/2017

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REFRIGERATION - CONTROL

ANTI-CONDENSATION HEATER CONTROL

Measure Description

This measure covers the installation of anti-condensation heater controls on glass door reach-in refrigerated cases. These controls save energy by reducing door heater run times based on feedback from door moisture sensors or dew point calculated via indoor air temperature and humidity sensors. Additional savings are achieved through interactive effects with the system's compressor. By running less often, door heaters emit less heat that must be overcome by the compressor. There are two primary categories of anti-condensation heater controls – (1) on/off controls and (2) pulse modulating controls. On/off controls cycle door heaters for several minutes at a time whereas pulse modulating controls pulse the door heaters at varying frequencies to satisfy calls for heating.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = (kW_{DH} \times hrs_{baseline}) - (kW_{DH} \times F_{PA} \times hrs_{ee})$$

Peak Coincident Demand Savings

$$\Delta kW = kW_{DH} \times F_{hrs} \times DF$$

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
kW_{DH}	= Total power of door heaters (in kW)
hrs	= Operating hours
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure
F_{PA}	= Power adjustment factor
F_{hrs}	= Operating hours reduction factor
DF	= Demand diversity factor

Summary of Variables and Data Sources

Variable	Value	Notes
kW_{DH}		From application, calculated based on door heater nameplate voltage and amperage.
$hrs_{baseline}$	8,760	Pre-installation operating hours; assumes 24/7, year-round operation of door heaters
hrs_{ee}	Coolers - 3,760 Freezers – 8,760	Post-installation operating hours. Freezer hours assume 24/7, year round operation of door heaters and varying power factors. Cooler hours estimated by National Resource Management (NRM) based on monitoring data collected of cooler door heater controls.[1]
F_{PA}	Coolers – 0.60 Freezers – 0.54	Average operating percentage of total door heater power after installation. Estimated by NRM based on monitoring data collected of cooler and freezer door heater controls. F_{PA} for freezers is calculated based on 4,000 hours of operation at 40% power and 4,760 hours at 65%.[2]
F_{hrs}	Coolers - 0.74 Freezers – 0.46	Annual operating hour reduction factor. Estimated by National Resource Management (NRM) based on monitoring data collected of cooler and freezer door heater controls.[3]
DF	0.75	Estimated adjustment to account for diversity and peak coincidence.[4]

Coincidence Factor (CF)

The recommended value for the coincidence factor is N/A. Adjustments to account for peak coincidence are embedded in the demand diversity factor defined above.

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a glass door reach-in refrigerated case anti-condensation heaters without temperature/humidity sensing controls.

Compliance Efficiency from which Incentives are Calculated

The compliance case is a glass door reach-in refrigerated case with on/off or pulse modulating anti-condensation heater controls installed.

Operating Hours

Anti-condensation door heaters without automated controls operate 24/7 year-round (8,760 hours annually). Operating hours for the compliance case are as specified above.

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

Effective Useful Life (EUL)

Years: 12
Source: DEER 2014[5]

Ancillary Fossil Fuel Savings Impacts

Reduction of door heater operation will slightly increase space heating load. However, these impacts are negligible and not considered at this time.

Ancillary Electric Savings Impacts

Reduction in door heater operation reduces heat that must be displaced by the compressor. Interactive effects are addressed in the prescribed energy savings calculation methodology.

References

1. National Resource Management monitoring data pending review.
2. *Cooler Control Measure Impact Spreadsheet Users' Manual*, Select Energy Services, Inc. for NSTAR, March 9, 2004
3. California Public Utilities Commission: Database for Energy Efficient Resources (DEER) – 2014, Updated-EULrecords_02-07-2014; EUL ID: GrocDisp-ASH. Available from: http://deeresources.com/files/deerchangelog/deerchangelog.html

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1	10/15/2010
9-17-10	9/30/2017

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[5] CA DEER – 2014 Updated EUL Records

APPENDIX P

EFFECTIVE USEFUL LIFE (EUL)

SINGLE AND MULTI-FAMILY RESIDENTIAL MEASURES

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Appliance	Advanced Power Strips	Residential	8	DEER 2014 EUL ID: Plug-OccSens
	Clothes Washer	Single-family	11	DEER 2014 EUL ID: Appl-EffCW
		Multi-family	14	DOE 2014
	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[5]
	Freezer Recycling	Residential	4[6]	DEER[7]
Building Shell	Air Leakage sealing	Residential	15	GDS[8]
	Hot Water Pipe Insulation	Residential	13 – Electric 11 – Natural Gas	DEER
	Opaque Shell Insulation	Residential	30	Energy Trust of Oregon and CEC[9]
	Window & Through the wall AC cover and Gap Sealer	Residential	5	See note below[10]
	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] DEER 2008 RUL assumptions, based on 1/3 of DEER EUL
[6] The hypothetical remaining years of use in the absence of removal of the appliance by the program
[7] DEER 2008 RUL assumptions, based on 1/3 of DEER
[8] IBID
[9] http://energytrust.org/library/reports/resource_assesment/gasrptfinal_ss103103.pdf
[10] 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[11]
	Heat Pump Water Heater – Air Source (HPWH)[12]	Residential	10	DEER[13]
	Indirect Water Heater	Residential	13	DEER[14]
	Storage Tank Water Heater	Residential	15	DEER
	Instantaneous Water Heater	Residential	20	DEER
Domestic Hot Water - Control	Faucet – Low Flow Aerator	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Shower Restriction Valve	Residential	10	UPC[15]
	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[16]
	Air Conditioner, Central (CAC)	Residential	15	DEER[17]
	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
	Boiler, Steam – Cast Iron	Residential	30	ASHRAE Handbook, 2015
	Circulator – with Electronically Commuted Motor (ECM) for Hydronic distribution	Residential	15	DEER[18]
	Duct sealing and Insulation	Residential	18	DEER
	Fan Motor – with Electronically Commuted Motor (ECM) for Furnace Distribution	Residential	15	DEER

[11] NYSERDA Energy Smart Program Deemed Savings Database. Rev 9 – 062006
[12] Electric heat pump used for service hot water heating
[13] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning from the California DEER website: www.deerurces.com
[14] Based on EUL of unfired (electric) water heater tank from DEER
[15] 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.
[16] Savings assumed to persist over EUL of air conditioner or heat pump
[17] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning. From the California DEER website: www.deeresidentialsources.com
[18] Based on DEER value for furnace fans

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Furnace, Gas Fired	Residential	18	ASHRAE Handbook, 2015
	Furnace Tune-up	Residential	5	See note below[19]
	Heat Pump - Air Source (ASHP)	Residential	15	DEER[20]
	Heat Pump – Ground Source (GSHP)	Residential	25	ASHRAE Cost Database[21]
	Unit Heater, Gas Fired	Residential	13	ASHRAE Handbook, 2015
HVAC - Control	Outdoor Reset Control for Hydronic Boiler	Residential	15	ACEEE[22]
	Thermostat – Programmable; Thermostat – Wi-Fi Communicating	Residential	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve	Multi-family	12	NYS DPS
Lighting	Compact Fluorescent Lamp (CFL)	Residential	Coupon – 5	GDS
			Direct Install – 7	GDS
			Markdown - 7	GDS
		Multi-family Common area	9,000 hrs/ annual lighting operating hrs	See note below[23]
	LED Lamps (Directional)	Residential/ Multi-family Common area	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Lamps[24]
			35,000 or 50,000 hours	DLC[25]

[19] Reduced from DEER value of 10 years
[20] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning. From the California DEER website: www.deeresidentialsources.com
[21] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://energy.gov/energysaver/geothermal-heat-pumps
[22] Potential for Energy Efficiency, Demand Response and Onsite Solar Energy in Pennsylvania, ACEEE report number E093. April 2009
[23] 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
[24] 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
[25] 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	LED Lamps (Decorative & Omnidirectional)		Residential/ Multi-family Common area	15,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Lamps
	Light Fixture	LED (Interior)	Residential/ Multi-family	25,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Fixtures[26]
		LED (Exterior)	Residential/ Multi-family Common area	35,000 hrs/ annual lighting operating hrs or 20 yrs (whichever is less)	ENERGY STAR Fixtures
		Linear Fluorescent	Residential / Multi-family Common area	70,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	DEER 2014[27] EUL ID: ILtg-Lfluor-CommArea
		CFL	Residential / Multi-family Common area	22,000 hrs / annual lighting operating hrs, or 20 yrs (whichever is less)	See note below[28]
Lighting Control	Stairwell Dimming Light Fixture/Sensor		Multi-family	12	GDS[29]

[26] 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
[27] Basis value 70,000 hours, capped at 20 years, is common given redecoration patterns
[28] Basis value 22,000 hour ballast life per US EPA. Capped at 20 years as above (2.5 hours per day average lamp operation)
[29] 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[30]
Appliance	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[31]
Compressed Air	Air Compressor Upgrade	C&I	15	Ohio TRM[32]
	Refrigerated Air Dryer	C&I	15	Ohio TRM
	Engineered Air Nozzle	C&I	15	PA Consulting for Wisconsin PSC[33]
	No Air Loss Water Drain	C&I	15	Ohio TRM[34]
Domestic Hot Water (DHW)	Domestic Hot Water Tank Blanket	C&I	7	DEER
	Indirect Water Heater	C&I	15	DEER[35]
	Storage Tank Water Heater	C&I	15	DEER
	Tankless Water Heater	C&I	20	DEER
	Heat Pump Water Heater - Air Source (HPWH)	C&I	10	DEER
DHW - Control	Faucet – Low Flow Aerator	C&I	10	DEER
	Showerhead – Low Flow	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Pre-Rinse Spray Valve	C&I	5	GDS

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

[31] 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

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

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

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

[35] EUL for commercial central water heater used

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner and Heat Pump – Refrigerant Charge Correction	C&I	10	DEER
	Air Conditioner – Package (PTAC)	C&I	15	DEER 2014 EUL ID: HVAC-airAC
	Chiller – Air & Water Cooled	C&I	20	DEER 2014 EUL ID: HVAC-Chlr
	Chiller – Cooling Tower	C&I	15	DEER
	Chiller Tune-Up	C&I	5	WI EUL DB[36]
	Combination Boiler and Water Heater	C&I	20	DEER[37]
	Condensing Gas-Fired Unit Heater for Space Heating	C&I	18	Ecotope[38]
	Duct Sealing and Insulation	C&I	18	DEER
	ECM Motors on HVAC Equipment	C&I	15	DEER[39]
	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
	Boiler Tune-Up	C&I	5	DEER 2014 EUL ID: BlrTuneup
	Furnace, Gas Fired	C&I	18	ASHRAE Handbook, 2015
	Unit Heater, Gas Fired	C&I	13	ASHRAE Handbook, 2015
	Heat Pump – Air Source, Package (PTHP)	C&I	15	DEER 2014 EUL ID: HVAC-airHP
	Infrared Gas Space Heater	C&I	17	GDS

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

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
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[40]
	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[41]
	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[42]
	CFL Light Fixture	C&I	12	DEER 2014 EUL ID: ILtg-CFLfix-Com
	HID	C&I	70,000 hours /annual lighting operating hours or 15 years (whichever is less)	DEER 2014 EUL ID: ILtg-HPS
	Linear Fluorescent	C&I	70,000 hours /annual lighting operating hours or 15 years, (whichever is less)	DEER 2014[43] EUL ID: ILtg-Lfluor-Elec

[40] Set to 15 years, consistent with Energy Management System (EMS) value in DEER
[41] DEER value for occupancy sensor controls. Hardwired (not battery powered) controls only
[42] Based on reported annual lighting operating hours; default value by space type in the technical manual (pp. 109-110)
[43] Basis Value 70,000 hours, capped at 15 years to reflect C&I redecoration and business type change patterns

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting	LED Fixtures (other than refrigerated case)	C&I	50,000 hours /annual lighting operating hours or 20 years (whichever is less)	DLC[44]
			35,000 hours /annual lighting operating hours or 20 years (whichever is less)	Energy Star[45]
			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[46]
	Plug-Load Occupancy Sensor	C&I	8	DEER[47]
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

[44] 50,000 hours per L_{70} requirements prescribed by the DLC's Product Qualification Criteria, Technical Requirement Table version 4.2

[45] 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

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

[47] DEER value for lighting occupancy sensors

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
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

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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
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
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
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 65° Fahrenheit. The temperature below which buildings need to be heated.
HID	High intensity discharge lamp
hp	Horsepower
HP	High performance
hrs	Hours
$hrs_{operating}$	Operating hours
HSPF	Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric heat) during the heating season / total electric energy heat pump consumed (in watt/hr)

ht	Height
HVAC	Heating, ventilation, and air conditioning
$HVAC_c$	HVAC interaction factor for annual electric energy consumption
$HVAC_d$	HVAC interaction factor at utility summer peak hour
$HVAC_g$	HVAC interaction factor for annual natural gas consumption
HW	Hot water
IECC	International Energy Conservation Code
IEER	Integrated energy efficiency ratio
IESNA	Illuminating engineering Society of North America
IPLV	Integrated Part-Load Value, a performance characteristic, typically of a chiller capable of capacity modulation.
k	Thermal conductivity
$KBTUh_{in}$	Annual gas input rating
$kBTUh_{out}$	Annual gas output rating
kW	Kilowatt
L	Length
LBNL	Lawrence Berkeley National Laboratory
leakage	Estimate of percent of units not installed in service territory
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LF	Load Factor
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

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
3.517	Conversion factor, one ton equals 3.516853 kilowatts
8.33	Energy required (BTU's), to heat one gallon of water by one degree Fahrenheit
12	kBTUh/ton of air conditioning capacity
67.5	Ambient air temperature °F
91	Days in winter months
274	Days in non-winter months.
365	Days in one year
3.412	Conversion factor, one watt/h equals 3.412142 BTU
3,412	Conversion factor, one kWh equals 3,412 BTU
8,760	Hours in one year
12,000	Conversion factor, one ton equals 12,000 BTU/h
1,000	conversion factor, one kW equals 1,000 Watts
100,000	conversion factor, (BTU/therm), one therm equals 100,000 BTU's

Record of Revision

Record of Revision Number	Issue Date
0	12/10/2014
6-15-4	6/1/2014
1-17-9	12/31/2016
6-17-17	6/30/2017
9-17-12	9/30/2017

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9/30/17 - Third Quarter Record of Revision TRM Filing
Detailed Work Plan

No.		Task	Estimated Completion Date	Effective Date in TRM	Comments
1		**File Q3 2017 ROR**			To be filed by Central Hudson on 9/29/17
		New Measures - none			
		Existing Measure Updates w/ effective date			
	R	Thermostat – Wi-Fi (Communicating)	9/30/2017	1/1/2018	
	C&I	Thermostat – Wi-Fi (Communicating)	9/30/2017	1/1/2018	
	C&I	Chiller – Air and Water Cooled	9/30/2017	1/1/2018	
	R	Light Emitting Diode (LED), Compact Fluorescent Lamp (CFL) and Other Lighting	9/30/2017	1/1/2018	
	C&I	Interior and Exterior Lamps and Fixtures	9/30/2017	1/1/2018	
	C&I	Refrigerated Case LED	9/30/2017	1/1/2018	
	C&I	Interior Lighting Control	9/30/2017	1/1/2018	
	C&I	Fan Motor – with Electronically Commutated (EC) Motor, for Refrigerated Case or Walk-In Cooler	9/30/2017	1/1/2018	
	C&I	Anti-Condensation Heater Control	9/30/2017	1/1/2018	
	C&I	Variable Frequency Drive – Fan and Pump	9/30/2017	1/1/2018	
		Appendix P	9/30/2017	1/1/2018	
		Glossary	9/30/2017	1/1/2018	
2		**Review EM&V studies filed by 9/15/17 for incorporation into 4/15/18 Annual Filing**	4/15/2018	1/1/2019	TRM MC meeting in October will identify and discuss EM&V studies filed within the last year. A review schedule will be developed during the October 2017 meeting to address potential TRM updates for inclusion in annual TRM filing 4/15/18
3		**File Q4 2017 ROR**			To be filed by NYSEG/RG&E 12/28/17
		New Measures			Measure list for Q4 is an estimate of the measures anticipated to be reviewedfor the quarter. This list is subject to change based on TRM MC priorities andworkload.
	C&I	Tier 1 APS (TrickleStar)	12/31/2017	1/1/2019	
	C&I	Clothes Dryer (National Fuel)	12/31/2017	1/1/2019	
		Existing Measure Updates w/ effective date			
	R	Blower Fan – with Electronically Commutated (EC) Motor, for Furnace Distribution	12/31/2017	1/1/2019	
	C&I	Air Conditioner– Unitary	12/31/2017	1/1/2019	
	C&I	Chiller - Cooling Tower	12/31/2017	1/1/2019	
	C&I	Furnace and Boiler	12/31/2017	1/1/2019	
	C&I	Heat Pump Air Source, Packaged (PTHP)	12/31/2017	1/1/2019	
	R	Heat Pump Water Heater (HPWH) -Air Source	12/31/2017	1/1/2019	
	R	Indirect Water Heater	12/31/2017	1/1/2019	
	R	Storage Tank and Instantaneous Domestic Water Heater	12/31/2017	1/1/2019	
	C&I	Storage Tank Water Heater	12/31/2017	1/1/2019	
	R	Refrigerator and Freezer Recycling	12/31/2017	1/1/2019	
	C&I	Air Compressor	12/31/2017	1/1/2019	
	R	Air Conditioner - Central (CAC)	12/31/2017	1/1/2019	
	R	Heat Pump - Air Source (ASHP)	12/31/2017	1/1/2019	
	C&I	Bi-Level Lighting	12/31/2017	1/1/2019	
	R	Clothes Dryer	12/31/2017	1/1/2019	
	R	Advanced Power Strip	12/31/2017	1/1/2019	
	C&I	Refrigerated Case Night Cover	12/31/2017	1/1/2019	
	C&I	Evaporator Fan Control	12/31/2017	1/1/2019	
	R	Air Conditioner - Room (RAC)	12/31/2017	1/1/2019	
	C&I	Economizer – Air Side, with dual enthalpy control	12/31/2017	1/1/2019	
4		**Complete TRM global updates (the entire manual)**	**12/31/2018**		