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December 31, 2015

VIA ELECTRONIC DELIVERY

Honorable Kathleen H. Burgess
Secretary
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

New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures, Version 3

Measure Updates

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, 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"), Central Hudson Gas and Electric Corporation, 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 2, 2015.

Pursuant to the Joint Utilities' Technical Resource Manual Management Plan filed with the Commission on June 1, 2015, a Technical Resource Manual Management Committee ("TRM MC") was established upon receipt of the NY TRM, Version 3, from the New York State Department of Public Service Staff.

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The TRM MC has met regularly, and in the course of so doing, has reviewed and unanimously approved the nineteen (19) measure updates attached hereto to Version 3 of the NY TRM to be effective January 1, 2016.

Respectfully submitted,

THE BROOKLYN UNION GAS COMPANY d/b/a NATIONAL GRID NY, KEYSPAN GAS EAST CORPORATION d/b/a NATIONAL GRID AND NIAGARA MOHAWK POWER CORPORATION d/b/a NATIONAL GRID

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New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs –

Residential, Multi-Family, and Commercial/Industrial Measures

Version 3.1

Issue Date - January 1, 2016
Effective Date – January 1, 2016

New York State Department of Public Service
Markets and Innovation, Office of Clean Energy
3 Empire State Plaza
Albany, New York 12223

Table of Revisions / Additions

Issue Date - January 1, 2016 Effective Date – January 1, 2016

Revisions and additions to the measures listed below were undertaken by the Joint Utilities (Technical Resource Manual) TRM Management Committee between July and December of 2015. These revisions are to be incorporated into Version 3.1 of the *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs–Residential, Multi-family, and Commercial/Industrial Measures effective January 1, 2016.*

R / A	Number	Measure	Description of Change	Location/Page in TRM Version 3
R	1-16-1	Glossary	Revised HDD Definition	pp. 503-507
R	1-16-2	R/MF - HVAC - Furnaces (and Boilers)	Updates Minimum Efficiencies as per NYCECC and ECCCNYS.	p. 95
R	1-16-3	R/MF - Lighting - Compact Fluorescent Lamp and Other Lighting Technologies	Revisions to Deemed LED Factor and Leakage Factor	p. 118
R	1-16-4	C/I - HVAC – Furnaces and Boilers	Updates Minimum Efficiencies as per NYCECC and ECCCNYS.	p. 182
R	1-16-5	C/I - HVAC – Control	Revised Programmatic thermostat to include WiFi enabled devices	p. 190
R	1-16-6	C/I - Lighting	Designate HVAC IF for Auto Related (24/7)	p. 196
R	1-16-7	C/I - Lighting – Control – Interior Lighting Control	Deletion of quantity of sensors controlling the same circuit load	p. 202
R	1-16-8	C/I - Refrigeration – Control	Revision to Fan Control Calculation	p. 223
R	1-16-9	Appendix G	Revision to NYC SFDC EFLH Values	pp. 404-409
A	1-16-10	R/MF – Appliance Control – Advanced Power Strip	Addition of Advanced (Smart) Power Strip Devices	N/A
A	1-16-11	R/MF - Lighting – Bi-Level Lighting Fixtures	Addition of Bi-Level Lighting Fixtures	N/A
A	1-16-12	R/MF - HVAC – Control – TRV	Addition of Thermostatic Radiator Valves for One Pipe Steam Systems	N/A
A	1-16-13	R/MF - HVAC – Control - EMS	Addition of Multi-Family EMS measure	N/A
A	1-16-14	C/I - HVAC – BPM	BPM Motor Retrofit for Existing Furnaces	N/A
A	1-16-15	C/I - Appliance Recycling - Room Air Conditioner	Addition of RAC for commercial applications	N/A
A	1-16-16	C/I - Refrigeration	Addition of Strip Curtains for Walk-In Units	N/A
A	1-16-17	C/I - Refrigeration	Addition of Door Gaskets Repair for Reach-In Display Cases	N/A
A	1-16-18	C/I - DHW – Control	Addition of Low Flow Spray Valve	N/A
R	1-16-19	R/MF - HVAC – Control	Revised Programmatic thermostat to include WiFi enabled devices	p. 114

GLOSSARY

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

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

F	Savings factor
FEMP	Federal Energy Management Program
FLH	Full-load hours
FLOW	Nozzle flow
FPFC	Four pipe fan coil
ft^2	Square foot
GDS	GDS Associates, Marietta, GA
Glazing area	Aperture area of glazing
GPD	Gallons per day
GSHP	Ground source heat pump
HDD	Heating degree day - The number of degrees that a day's average temperature is below 65oFahrenheit). The temperature below which buildings need to be heated.
HID	High intensity discharge lamp
hp	Horsepower
HP	High performance
hrs	hours
$hrs_{operating}$	Operating hours
HSPF	Heating seasonal performance factor, total heating output (supply heat) in BTU (including electric heat) during the heating season / total electric energy heat pump consumed (in watt/hr)
ht	Height
HVAC	Heating, ventilation, and air conditioning
$HVAC_c$	HVAC interaction factor for annual electric energy consumption
$HVAC_d$	HVAC interaction factor at utility summer peak hour
$HVAC_g$	HVAC interaction factor for annual natural gas consumption
HW	Hot water
IECC	International Energy Conservation Code
IEER	Integrated energy efficiency ratio
IESNA	Illuminating engineering Society of North America
IPLV	Integrated Part-Load Value, a performance characteristic, typically of a chiller capable of capacity modulation.
k	Thermal conductivity
$KBTUh_{input}$	Annual gas input rating
$kBTUh_{output}$	Annual gas output rating
kW	Kilowatt
L	Length
LBNL	Lawrence Berkeley National Laboratory
leakage	Estimate of percent of units not installed in service territory
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LPD	Lighting power density
LRAC	Long-run avoided cost
LSAF	Load shape adjustment factor
MEC	Metropolitan Energy Center
NAECA	National Appliance Energy Conservation Act of 1987
NBI	New Buildings Institute

NEA	National Energy Alliances
NEAT	National Energy Audit Tool
NEMA	National Electrical Manufacturers Association
NREL	National Renewable Energy Laboratory
NRM	National Resource Management
NSTAR	Operating company of Northeast utilities
NWPPC	Northwest Power Planning Council
NWRTF	Northwest Regional Technical Forum
NY DPS	New York State Department of Public Service
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
^{o}F	Degrees Fahrenheit
OSA	Outdoor supply air
PA Consulting	PA Consulting Group
PF	Power factor
Phase	Number of phases in a motor (1 or 3) Single Phase is a type of motor with low horsepower that operates on 120 or 240 volts, often used in residential appliances. Three phase is a motor with a continuous series of three overlapping AC cycles offset by 120 degrees. Three-phase is typically used in commercial applications.
PLR	Power loss reduction
PNNL	Pacific Northwest National Laboratory
PSC	Public Service Commission, New York State
PSF	Proper sizing factor
PSZ	Packaged single zone
PTAC	Package terminal air conditioner
PTHP	Packaged terminal heat pump
Q	Heat
$Q_{reduced}$	Reduced heat
Q_{reject}	Total heat rejection
r	Radius
RA	Return air
RAC	Room air conditioner
RE	Recovery efficiency
RECS	Residential Energy Consumption Survey
RESNET	Residential Energy Services Network
RH	Reduced heat
RLF	Rated load factor
RPM	Revolutions per minute
R-value	A measure of thermal resistance particular to each material
S	Savings
SAPA	State Administrative Procedure Act
SBC	System Benefit Charge
SCFM	Standard cubic feet per minute @ 68 ^{o}F and 14.7 psi standard condition
SEER	Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
sf	Square foot

SHGC	Solar heat gain coefficient
SL	Standby heat loss
Staff	NYS Department of Public Service Staff
T	Temperature
TAF	Temperature adjustment factor
TEFC	Totally enclosed fan cooled
th	Thickness
therm	Unit of heat
THR	Total heat rejection
TMY	Typical meteorological year
tons	Tons of air conditioning
tons/unit	Tons of air conditioning per unit, based on nameplate data
TRC	Total Resources Cost
TRM	Technical Resource Manual
UA	Overall heat loss coefficient (BTU/hr-°F)
unit	Measure
units	Number of measures installed under the program
UPC	Uniform Plumbing Code under the International Association of Plumbing and Mechanical Officials
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
U-value	Measure of heat loss in a building element/overall heat transfer co-efficient
V	Volt
v	Volume
VAV	Variable air volume
VSD	Variable speed drive
W	Watts
w	Width
Wisconsin PSC	State of Wisconsin Public Service Commission

Record of Revision

Record of Revision Number	Issue Date
1-16-1	1-1-2016

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FURNACE AND BOILER

Measure Description

This measure includes high efficiency gas fired furnaces, boilers, and unit heaters in low-rise residential building applications.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$\Delta kWh = N/A$

Peak Coincident Demand Savings

$\Delta kW = N/A$

Annual Gas Energy Savings

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

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
$\Delta therms$ = Annual gas energy savings
units = Number of measures installed under the program
$kBTUh_{in}$ = Fuel Input Rating
η_{ee} = Energy efficient condition or measure
$\eta_{baseline}$ = Baseline condition or measure
$EFLH_{heating}$ = Equivalent full-load hours
100 = Conversion factor, (kBTU / Therm)

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTUh_{in}$ / unit		Nominal heating input capacity is the nameplate input rating of the unit in kBTU/ hr, from application.
$\eta_{baseline}$	See Baseline Efficiency	Baseline established by applicable energy conservation code, climatic zone, equipment type and size, fuel source, as well as system configuration.
η_{ee}	See Compliance Efficiency	From application; use metrics consistent with baseline
$EFLH_{heating}$		Lookup based on building type and location, Appendix G

Efficiency is expressed as the ratio between the fuel input relative to the output. The efficiency of furnace, boilers, and unit heaters is customarily evaluated on the basis of one or more of three standards, and are referred to as Thermal Efficiency (E_t), Combustion Efficiency, (E_c) or Annual

Fuel Utilization Efficiency (*AFUE)* values respectively.

Presently the AFUE value is only applicable to smaller units. For larger units use thermal and combustion efficiencies referenced on manufacturer's nameplate data in accordance with nationally recognized standards and testing agencies.

Coincidence Factor (CF)

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

Baseline Efficiencies From Which Savings are Calculated

The baseline efficiency for residential furnaces, boilers, and unit heaters (η_{base}) is defined by the Code of Federal Regulations (CFR) and subsequently adopted by the Energy Conservation Code of New York State[1], and the New York City Energy Conservation Code[2] as shown below:

Equipment Type (natural gas)	**Size Range**	**ECCCNYS Minimum Efficiency for climate zones 4, 5, and-6**	**NYCECC Minimum Efficiency for NYC boroughs in climate zone 4**
Warm Air Furnace, gas fired	< 225 kBtu/h	78% AFUE or 80% Et	80% AFUE or 80% Et
	≥ 225 kBtu/h and < 500 kBtu/h	80% Et	81% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h		
Warm Air Unit Heaters, gas fired	All Capacities	80% Ec	80% Ec
Boiler, non-condensing, hot water, gas fired	< 300 kBtu/h	80% AFUE	82% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	80% Et	83% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	82% Ec	85% Ec
Boiler, condensing, hot water, gas fired	< 300 kBtu/h	80% AFUE	82% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	80% Et	83% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	82% Ec	85% Ec
Boilers, steam, all except natural draft	< 300 kBtu/h	75% AFUE	80% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	79% Et	80% Et
	> 2,500 kBtu/h	79% Et	80% Et
Boilers, steam, natural draft	< 300 kBtu/h	75% AFUE	80% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	77% Et	79% Et
	> 2,500 kBtu/h	77% Et	79% Et

Compliance Efficiencies From Which Incentives are Calculated

Equipment Type (natural gas)	Size Range	Minimum Compliance Efficiency for climate zones 4, 5, and-6	Minimum Compliance Efficiency for NYC boroughs in climate zone 4
Warm Air Furnace, gas fired	< 225 kBtu/h	92% AFUE	92% AFUE
	≥ 225 kBtu/h and < 500 kBtu/h	90% Et	90% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h		
Warm Air Unit Heaters, gas fired	All Capacities	83% Ec	83% Ec
Boiler, non-condensing, hot water, gas fired	< 300 kBtu/h	85% AFUE	85% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	85% Et	85% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	88% Ec	88% Ec
Boiler, condensing, hot water, gas fired	< 300 kBtu/h	90% AFUE	90% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	90% Et	90% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	93% Ec	93% Ec
Boilers, steam, all except natural draft	< 300 kBtu/h	82% AFUE	82% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	82% Et	82% Et
	> 2,500 kBtu/h	82% Ec	82% Ec
Boilers, steam, natural draft	< 300 kBtu/h	82% AFUE	82% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	82% Et	82% Et
	> 2,500 kBtu/h	82% Ec	82% Ec

Operating Hours

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

Effective Useful Life (EUL)[3]

Furnaces, Gas Fired	18 Years
Unit Heater, Gas Fired	13 Years
Boilers, Hot Water – Steel Water Tube	24 Years
Boilers, Hot Water – Steel Fire Tube	25 Years
Boilers, Hot Water – Cast Iron	35 Years
Boilers, Steam – Steel Water Tube	30 Years
Boilers, Steam – Steel Fire Tube	25 Years
Boilers, Steam – Cast Iron	30 Years

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

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

References

1. ECCCNYS 2010
2. NYCECCC 2014
3. Comparison of Service Life Estimates, 2015 ASHRAE Handbook - Applications

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
6-15-7	6/1/2015
1-16-2	1/1/2016

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LIGHTING

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

Measure Description

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

Standard Calculation Method for Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = (units \times (1\text{-}leakage)) \times \Delta W / 1{,}000 \times hrs_{op.} \times (1 + HVAC_c)$$

Peak Coincident Demand Savings

$$\Delta kW = ((units \times (1\text{-}leakage)) \times \Delta W / 1{,}000 \times (1 + HVAC_d) \times 0.08$$

Annual Gas Energy Savings

$$\Delta therms = ((units \times (1\text{-}leakage)) \times (\Delta kWh \times 3.412\ BTU) \times HVAC_g$$

Alternative Calculation Method for Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = (units \times (1\text{-}leakage)) \times (W\ x\ F) / 1{,}000 \times hrs_{op.} \times (1 + HVAC_c)$$

Peak Coincident Demand Savings

$$\Delta kW = ((units \times (1\text{-}leakage)) \times (W\ x\ F) / 1{,}000 \times (1 + HVAC_d) \times 0.08$$

Annual Gas Energy Savings

$$\Delta therms = ((units \times (1\text{-}leakage)) \times ((W\ x\ F) \times 3.412\ BTU)) \times HVAC_g$$

where:

ΔkWh = Annual Electric Energy Savings
ΔkW = Peak Coincident Demand Savings
$\Delta therms$ = Annual Gas Energy Savings
Units = Number of Measures Installed
1,000 = Conversion factor, one kW equals 1,000 watts
leakage = Percentage of Units Not Installed in Service Territory, Estimated Percentage
Δ = Change, Savings or Consumption
W = Watts, Rated Wattage of Lamp and/or Fixture
baseline = Baseline Condition
ee = Energy Efficient Measure
0.08 = Coincidence Factor, Average Summer Value
$hrs_{op.}$ = Operating Hours
F = Conversion Factor, Alternative Method, see Table for value
3.412 = Conversion Factor, one watt/h equals 3.412142 BTU
$HVAC_c$ = HVAC Interaction Factor for annual electric energy consumption
$HVAC_d$ = HVAC Interaction Factor at utility summer peak hour
$HVAC_g$ = HVAC Interaction Factor for annual natural gas consumption

Summary of Variables and Data Sources

Variable	Value	Notes
units		From application, invoices or other documentation. Equal to number of lamps installed and operating.
F	see Table for value	Conversion Factor, Alternative Method
W		Energy Efficient measure watts, for use with Alternative Method
ΔW	$Watts_{baseline}$ – $Watts_{ee}$	For LEDs, CFLs and other lighting (not including incandescent or halogen lamp replacement), For use with Standard Method
$hrs_{operating}$	1,168 (lamps) 913 (fixtures)	Lighting operating hours
Coincidence factor	0.08	Use average summer value
$HVAC_c$		HVAC interaction factor for annual electric energy consumption. Vintage and HVAC type weighted average by city (see Appendix D)
$HVAC_d$		HVAC interaction factor at utility summer peak hour. Vintage and HVAC type weighted average by city (see Appendix D)
$HVAC_g$		HVAC interaction factor for annual natural gas consumption. Vintage and HVAC type weighted average by city (see Appendix D)

Estimated Conversion Factor when Using the Alternative Calculation Method

F	Conversion Factor for Replacement Lamps
2.53	Replacement of Incandescent with Compact Fluorescent Lamp (CFL)
1.55	Replacement of Halogen with Compact Fluorescent Lamp (CFL)
4.94	Replacement of Incandescent with Light Emitting Diode Lamp (LED)
0.53	Replacement of Compact Fluorescent Lamp with Light Emitting Diode Lamp (LED)

The alternative calculation method is only applicable when the rated wattage of the unit to be replaced cannot otherwise be determined. When the type of lamp to be replaced is not known, it is assumed that the lamp is incandescent.

Operating Hours

Lamps

Hours of operation for lamps are estimated to be 3.2 operating hours per day or 1168 (3.2 x 365) hours per year. The 3.2 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island, and Vermont.[1] 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.[2] 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.

Fixtures

Hours of operation for fixtures are estimated to be 2.5 operating hours per day or 913 (2.5 x 365) hours per year. The 2.5 operating hours per day is a value derived from an extended (nine month – May through February) logger study conducted during 2003 in Massachusetts, Rhode Island, and Vermont.[3] The Connecticut 2008 Program Savings Documentation uses 2.6 hours per day,

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

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

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

based on a 2003 Connecticut-based study. A study of the 2005-2006 residential lighting program for Efficiency Maine reports daily hours of use at 2.4 for interior fixtures.[4] The proposed value represents a trade-off among factors that may affect the extent to which any value from outside of New York State is applicable to NY. These include such factors as differences between the study area and NY related to maturity of the CFL markets, program comparability, consumer knowledge of CFLs, and mix of locations within the house (which affects average hours of use). On balance, in considering the data and reports reviewed to date, 2.5 appears to be the most reasonable prior to New York specific impact studies.

Leakage (In-Service Rate)

This defined term is used to describe unit that may not ultimately be placed in to service within the utility territory. Leakage occurs primarily in retail and educational (upstream) programs, where the Program Administrator does not have control over either who purchases the lamps or where they are ultimately installed therefore reducing the anticipated savings.

The values are used to estimate savings per lamp, and must be multiplied by the number of lamps installed and operating. For some programs, such as upstream programs, an adjustment to the unit count must be made for lamps that may have been placed in inventory and not sold, sold to customers living outside New York State, or placed into storage and not used.

Coincidence Factor (CF)

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

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

Lighting Winter On-Peak Hours (5pm – 7pm)	Coincidence Factor
December	0.28
January	0.32
Average Winter	0.30

Baseline Efficiencies from which Savings are Calculated

The Baseline Efficiency is defined as the fixture wattage of the lamp or lighting fixture. The baseline condition is assumed to be the existing operational lamp or lighting fixture in all applications other than when required by the applicable energy conservation code to be replaced with minimally compliant lamps or fixtures. When labeled ratings are not available, see table of standard fixture wattages in Appendix C.

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

Compliance Efficiencies from which Savings are Calculated

Effective Useful Life (EUL)

See Appendix P: Effective Useful Life (EUL)

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

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

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	1/1/2016

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FURNACE AND BOILER

Measure Description

This measure includes high efficiency gas fired furnaces, boilers, and unit heaters in buildings except low-rise residential building applications.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

ΔkWh = N/A

Peak Coincident Demand Savings

ΔkW = N/A

Annual Gas Energy Savings

$$\Delta\text{therms} = \text{units x} \left(\frac{\text{kBTUh}_{\text{in}}}{\text{unit}}\right) \text{x} \left(\frac{\eta_{ee}}{\eta_{baseline}} - 1\right) \text{x} \left(\frac{EFLH_{\ heating}}{100}\right)$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
Δtherms = Annual gas energy savings
units = Number of measures installed under the program
$kBTUh_{in}$ = Fuel input rating
η_{ee} = Energy efficient condition or measure
$\eta_{baseline}$ = Baseline condition or measure
$EFLH_{\ heating}$ = Equivalent full-load hours
100 = Conversion factor, (kBTU / Therm)

Summary of Variables and Data Sources

Variable	Value	Notes
$kBTUh_{in}$ / unit		Nominal heating input capacity is the nameplate input rating of the unit in kBTU/ hr, from application.
$\eta_{baseline}$	See Baseline Efficiency	Baseline established by applicable energy conservation code, climatic zone, equipment type and size, fuel source, as well as system configuration.
η_{ee}	See Compliance Efficiency	From application; use metrics consistent with baseline
$EFLH_{heating}$		Lookup based on building type and location, Appendix G

Efficiency is expressed as the ratio between the fuel input relative to the output. The efficiency of furnace, boilers, and unit heaters is customarily evaluated on the basis of one or more of three standards, and are referred to as Thermal Efficiency (E_t), Combustion Efficiency, (E_c) or Annual Fuel Utilization Efficiency (*AFUE)* values respectively.

Presently the AFUE value is only applicable to smaller units. For larger units use thermal and combustion efficiencies referenced on manufacturer's nameplate data in accordance with nationally recognized standards and testing agencies.

Coincidence Factor (CF)

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

Baseline Efficiencies

The baseline efficiency for commercial furnaces, boilers, and unit heaters (η_{base}) is defined by the Code of Federal Regulations (CFR) and subsequently adopted by the Energy Conservation Code of New York State[1], and the New York City Energy Conservation Code[2] as shown below:

Equipment Type (natural gas)	Size Range	ECCCNYS Minimum Efficiency for climate zones 4, 5, and-6	NYCECC Minimum Efficiency for NYC boroughs in climate zone 4
Warm Air Furnace, gas fired	< 225 kBtu/h	78% AFUE or 80% Et	80% AFUE or 80% Et
	≥ 225 kBtu/h and < 500 kBtu/h	80% Et	81% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h		
Warm Air Unit Heaters, gas fired	All Capacities	80% Ec	80% Ec
Boiler, non-condensing, hot water, gas fired	< 300 kBtu/h	80% AFUE	82% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	80% Et	83% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	82% Ec	85% Ec
Boiler, condensing, hot water, gas fired	< 300 kBtu/h	80% AFUE	82% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	80% Et	83% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	82% Ec	85% Ec
Boilers, steam, all except natural draft	< 300 kBtu/h	75% AFUE	80% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	79% Et	80% Et
	> 2,500 kBtu/h	79% Et	80% Et
Boilers, steam, natural draft	< 300 kBtu/h	75% AFUE	80% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	77% Et	79% Et
	> 2,500 kBtu/h	77% Et	79% Et

Compliance Efficiencies

Equipment Type (natural gas)	Size Range	Minimum Compliance Efficiency for climate zones 4, 5, and-6	Minimum Compliance Efficiency for NYC boroughs in climate zone 4
Warm Air Furnace, gas fired	< 225 kBtu/h	92% AFUE	92% AFUE
	≥ 225 kBtu/h and < 500 kBtu/h	90% Et	90% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h		
Warm Air Unit Heaters, gas fired	All Capacities	83% Ec	83% Ec
Boiler, non-condensing, hot water, gas fired	< 300 kBtu/h	85% AFUE	85% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	85% Et	85% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	88% Ec	88% Ec
Boiler, condensing, hot water, gas fired	< 300 kBtu/h	90% AFUE	90% AFUE
	≥ 300 kBtu/h and < 500 kBtu/h	90% Et	90% Et
	≥ 500 kBtu/h and < 1,000 kBtu/h		
	≥ 1,000 kBtu/h and ≤ 2,500 kBtu/h		
	> 2,500 kBtu/h	93% Ec	93% Ec
Boilers, steam, all except natural draft	< 300 kBtu/h	82% AFUE	82% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	82% Et	82% Et
	> 2,500 kBtu/h	82% Ec	82% Ec
Boilers, steam, natural draft	< 300 kBtu/h	82% AFUE	82% AFUE
	≥ 300 kBtu/h and ≤ 2,500 kBtu/h	82% Et	82% Et
	> 2,500 kBtu/h	82% Ec	82% Ec

Operating Hours

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

Effective Useful Life (EUL)[3]

Furnaces, Gas Fired	18 Years
Unit Heater, Gas Fired	13 Years
Boilers, Hot Water – Steel Water Tube	24 Years
Boilers, Hot Water – Steel Fire Tube	25 Years
Boilers, Hot Water – Cast Iron	35 Years
Boilers, Steam – Steel Water Tube	30 Years
Boilers, Steam – Steel Fire Tube	25 Years
Boilers, Steam – Cast Iron	30 Years

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

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

References

1. ECCCNYS 2010
2. NYCECCC 2014
3. Comparison of Service Life Estimates, 2015 ASHRAE Handbook - Applications

Record of Revision

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

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HEATING, VENTILATION AND AIR CONDITIONING (HVAC) – CONTROL

THERMOSTAT

PROGRAMMABLE SETBACK (NON-COMMUNICATING) AND WIFI (COMMUNICATING)

MEASURE DESCRIPTION

This section covers programmable setback thermostats (non-communicating) and Wi-Fi communicating thermostats applied to air conditioners, heat pumps and/or furnaces and boilers in small commercial buildings.

Measure Description

Programmable setback thermostats applied to air conditioners, heat pumps and/or furnaces and boilers in small commercial buildings.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times (tons/unit \times \left(\frac{12}{SEER}\right) \times EFLH_{cooling} \times ESF_{cooling}) + (\left(\frac{kBTUh_{out}}{unit}\right) \times \left(\frac{EFLH_{heating}}{HSPF}\right) \times ESF_{heating})$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = units \times \left(\frac{kBTUh_{in}}{unit}\right) \times \frac{EFLH_{heating}}{100} \times ESF_{heating}$$

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
tons/unit	= Tons of air conditioning per unit, based on nameplate data
heating	= Heating system
cooling	= Cooling system
out	= Output capacity
in	= Input capacity

12 = kBTUh/ton of air conditioning capacity
ESF = Energy savings factor
SEER = Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)
HSPF = Heating seasonal performance factor (BTU/watt-hr), a measure of the seasonal average efficiency of the heat pump in the heating mode
EFLH = Equivalent full-load hours

Summary of Variables and Data Sources

Variable	Value	Notes
tons		From application, or use 5 ton as default. Use 0 if no central cooling
$SEER_{baseline}$	10	
$EFLH_{cooling}$		Vintage weighted average by city.
$ESF_{cooling}$	0.09	
If heat pump:		
$kBTUh/unit_{out}$		The nominal rating of the heating output capacity of the heat pump in kBTU/hr (including supplemental heaters), from application.
$HSPF_{baseline}$	6.8	
If furnace:		
$kBTUh_{in}/unit$		The nominal rating of the heating input capacity of furnace or boiler kBTUh, from application.
If boiler:		
$kBTUh_{in}/unit$		From application.
$EFLH_{heating}$		Vintage weighted average by city.
$ESF_{heating}$	0.068	

The SEER is an estimate of the seasonal energy efficiency for an average US city. The $\mathbf{EER_{pk}}$ is an estimate of the efficiency of the unit under peak summer conditions. See the section on packaged air conditioners above for more information.

The HSPF is an estimate of the seasonal heating energy efficiency for an average US city. See section on air source heat pumps above for more information.

The ***average seasonal efficiency*** of the furnace is the ratio of the heating output to the fuel input (in consistent units) over a heating season. See section on high efficiency furnaces above for more information.

The ***nominal rating of the cooling capacity of the air conditioner or heat pump*** should set equal to the rated capacity of all cooling equipment controlled by a setback thermostat in the building.

The ***nominal rating of the heating capacity*** of the furnace should set equal to the rated input capacity of all heating equipment controlled by a setback thermostat in the commercial facility. Nameplate capacity for heat pumps should include the full output heating capacity of the heat pump system, including backup electric resistance heaters.

The ***Energy Savings Factor*** (ESF) is the ratio of the energy savings resulting from installation of a programmable setback thermostat to the annual cooling energy.

Coincidence Factor (CF)

The recommended value for the coincidence factor is N/A

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency for air conditioners and heat pumps should be set to according to the sections on air conditioner and heat pump efficiency above.

Studies of residential heating thermostat set point behavior indicate some amount of manual setback adjustment in homes without programmable thermostats. This behavior is assumed to be present in the small commercial buildings addressed in this Tech Manual.

Compliance Efficiency from which Incentives are Calculated

The energy savings factor (ESF) assumption is taken from a study of programmable thermostat savings in Massachusetts conducted by GDS Associates for KeySpan Energy Delivery. The study estimated an energy savings of 3.6% of the annual heating energy consumption for programmable setback thermostats in residential applications. This assumption is also applied to the small commercial buildings addressed in this Tech Manual.

Operating Hours

Heating equivalent full-load hours calculated from building energy simulation models described in Appendix A and summarized in Appendix G.

Effective Useful Life (EUL)

Years: 11
Source: DEER

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. Energy Saving Factor for setback thermostats taken from "Programmable Thermostats. Report to KeySpan Energy Delivery on Energy Savings and Cost Effectiveness," GDS Associates, Marietta, GA. 2002.

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010

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THERMOSTAT – Wi-Fi (COMMUNICATING)

Measure Description

This section covers Wi-Fi communicating thermostats 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. The unit must contain an outdoor air temperature algorithm in the unit's control logic to operate the primary heating and cooling systems.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Unit savings are deemed based on a recent evaluation study from New England[1].

Annual Gas Energy Savings

Δtherms = Annual gas savings per thermostat unit of 63 therms.

Annual Electric Energy Savings (Cooling)

ΔkWh = Annual electric energy savings per thermostat unit of 104 kWh.

Peak Coincident Demand Savings

ΔkW = Annual peak demand savings per thermostat unit of 0.23 kW.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency is an HVAC system using natural gas or electricity to provide space heating with either a manual or a programmable thermostat.

Compliance Efficiency from which Incentives are Calculated

The higher energy efficiency level is an HVAC system that has a Wi-Fi thermostat installed.

Effective Useful Life (EUL)

Years: 11
Source: DEER

Record of Revision

Record of Revision Number	Issue Date
1-16-5	1/1/2016

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[1] Cadmus Group (September 2012) Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation for the Electric and Gas Program Administrators of Massachusetts

LIGHTING

INTERIOR AND EXTERIOR LAMPS AND FIXTURES

Measure Description

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

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

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

$$\Delta therm = units \times \Delta kWh \times HVAC_g$$

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:

Annual Electric Energy Savings

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

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

$$\Delta therm = units \times \Delta kWh \times HVAC_g$$

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 at utility summer peak hour
$HVAC_g$	= HVAC interaction factor for annual natural gas consumption

Summary of Variables and Data Sources

Variable	Value	Notes
$Units_{baseline}$		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_{ee}	Watts	Connected load of the energy-efficient unit, from application
$W_{baseline}$	Watts	Connected load of the baseline unit(s) displaced, from application
$hrs_{operating}$		Lighting operating hours. From application or default, as listed below in the Operating Hours table.
$LPD_{baseline}$		Lighting power density (W/SF) for baseline measure, from application, based on NY State Energy Conservation code. New construction or major renovation only.
LPD_{ee}		Lighting power density (W/SF) for energy efficient measure, from application, based on installed system design. New construction or major renovation only.
area		floor area illuminated by lighting system (SF)
$HVAC_d$		HVAC interaction factor at utility summer peak hour, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
$HVAC_c$		HVAC interaction factor for annual electric energy

Variable	Value	Notes
		consumption, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
$HVAC_g$		HVAC interaction factor for annual natural gas consumption, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
Building type		From application.
City		From application
Fixture location	Indoor, outdoor	From application; assume indoor if not known

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

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

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

Coincidence Factor (CF)

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

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

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

Baseline Efficiencies from which Savings are Calculated

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

Compliance Efficiency from which Incentives are Calculated

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

Operating Hours

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

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

[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.

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

(1) Lighting operating hours data from the 2008 California DEER Update study
(2) Lighting operating hours data for offices used

Effective Useful Life (EUL)

Measure	Years	Source
CFL Lamp	9,000 hours /annual lighting operating hours	See note below
CFL Light Fixture	12	DEER
Interior & Exterior, including linear fluorescent	70,000 hours /annual lighting operating hours or 15 years (whichever is less)	DEER
Interior Dry Transformers	25	Conservative estimate based on DOE value
LEDs Fixtures and Screw-In Lamps (other than refrigerated case)	35,000 or 50,000 hours	DLC
	35,000 hours	Energy Star
	15,000 hours(decorative) or 25,000 (all other)	Energy Star
	25,000 hours	Uncertified
Refrigerated Case LED	6	NW RTF

Ancillary Fossil Fuel Savings Impacts

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

Ancillary Electric Savings Impacts

References

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

Record of Revision

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

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LIGHTING – CONTROL

INTERIOR LIGHTING CONTROL

Measure Description

This section covers lighting control measures, including occupancy sensors, photocell controls, time clocks, stepped and dimming day lighting controls, dimmers and programmable control systems. 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

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

Peak Coincident Demand Savings

$$\Delta kW = (W_{ctrl} / 1{,}000) \times (1 + HVAC_d) \times DSF \times CF$$

Annual Gas Energy Savings

$$\Delta therms = \Delta kWh \times HVAC_g$$

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
1,000	= Conversion factor, one kW equals 1,000 watts
W	= Watts
ctrl	= Control
baseline	= Baseline condition or measure
ee	= Energy efficient condition or measure
CF	= Coincidence factor
DSF	= Demand savings factor
$hrs_{operating}$	= Lighting operating hours
$HVAC_c$	= HVAC interaction factor for annual electric energy consumption
$HVAC_d$	= HVAC interaction factor at utility summer peak hour
$HVAC_g$	= HVAC interaction factor for annual natural gas consumption

Summary of Variables and Data Sources

Variable	Value	Notes
W_{ctrl}	Watts	Connected load of controlled lighting fixtures, from application
Control type		From application
$hrs_{operating, baseline}$		Lighting operating hours. From application
$hrs_{operating, ee}$		Lighting operating hours. From application
$HVAC_d$		HVAC interaction factor at utility summer peak hour, Lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
$HVAC_c$		HVAC interaction factor for annual electric energy consumption, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
$HVAC_g$		HVAC interaction factor for annual natural gas consumption, lookup by building type with weighted average across HVAC types. Average upstate values or NYC. Use 0 for lights in unconditioned space.
Building type		From application.
City		From application
Fixture location	Indoor, outdoor	From application; assume indoor if not known

The ***demand savings factor*** (DSF) is the maximum hourly reduction in lighting demand achieved by a particular control measure. Lighting controls save energy and demand by reducing or shutting off power input to lighting fixtures in response to a control signal. Demand savings can be achieved by the following controllers and their respective control actions:

- Occupancy sensors - Switching off lights when the space is unoccupied.
- Daylight sensing controls - Reducing electric lighting levels according to the availability of daylight.
- Dimming controls - Reducing lighting levels to suit the occupant.
- Time clocks - Switching off lights according to a fixed schedule.
- Photocells - Controlling outdoor lights according to the availability of daylight. These may be combined with time clock control.
- Programmable control systems - Sophisticated lighting controllers that combine many of the above functions into a single unit and may also be coupled to the building security system.

Coincidence Factor (CF)

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

For many utilities, summer peak demand occurs in the afternoon, indicating a coincidence factor of 1.0 for commercial indoor lighting measures. Since exterior lighting is generally off during daylight hours, the coincidence factor for exterior lighting is 0.0.

See Appendix D for HVAC interaction factors.

Baseline Efficiencies from which Savings are Calculated

Baseline calculations assume no lighting controls are installed, except those required by local energy code as applicable.

Compliance Efficiency from which Incentives are Calculated

Lighting controls designed and installed in accordance with manufacturers' and/or designer recommendations.

Operating Hours

The baseline lighting operating hours are the average operating hours for all fixtures subject to lighting control measures before the lighting controls are installed. Lighting operating hours for a variety of commercial and residential buildings are discussed in the lighting efficiency section above. The measure lighting operating hours can be entered directly if known, or calculated from:

$$hrs_{operating,\ ee} = hrs_{operating,\ baseline} \times (1 - ESF)$$

where:

ESF = energy savings factor
$hrs_{operating}$ = lighting operating hours
baseline = Baseline condition or measure
ee = Energy efficient condition or measure

Energy Savings Factors for Various Automatic Control Options

Control Type	DSF
Occupancy sensor	0.30
Programmable control	0.15
Daylight dimming control	0.30
Daylight stepped control	0.20

Effective Useful Life (EUL)

Years: 8
Source: DEER

Ancillary Fossil Fuel Savings Impacts

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

Ancillary Electric Savings Impacts

References

1. Energy and demand savings factors derived from lighting control power adjustment factors prescribed in the California Title 24 Nonresidential lighting standards.

Record of Revision

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

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EVAPORATOR FAN CONTROL

Measure Description

Walk-in cooler and freezer evaporator fans often run continually, requiring more air to be blown across the evaporator than needed to cool the evaporator. This measure consists of a control system that turns the fan on only when the unit's thermostat is calling for the compressor to operate, shutting the fan off shortly after the desired temperature is reached and the compressor is turned off.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh\ Evap_{off} + \Delta kWh\ Evap_{reduced} + \Delta kWh\ Comp\_Evap_{ctrl}$$

where:

$\Delta kWh\ Evap_{off}$ = Savings due to Evaporator Fan being off
$\Delta kWh\ Evap_{reduced}$ = Savings due to reduced heat from Evaporator Fans
$\Delta kWh\ Comp\_Evap_{ctrl}$ = Savings due to the electronic controls on compressor and evaporator

$$\Delta kWh\ Evap_{off} = kW_{fan} \times FLH_{fan} \times F_{off}$$

where:

kW_{fan} = Fan kW ($V \times A \times \sqrt{Phase}_{fan} \times PF_{fan}$)
V_{fan} = Nameplate fan volts
A_{fan} = Nameplate fan amperage
$Phase_{fan}$ = Number of phases (1 or 3)
PF_{fan} = Power factor for fan motor
FLH_{fan} = Annual operating hours
Fan_{off} = Fraction of time that Evaporator Fan is turned off.

$$\Delta kWh\ Evap_{reduced} = \Delta kWh\ Evap_{off} \times 0.285 \times kW/ton$$

where:

$\Delta kWh\ Evap_{off}$ = Savings due to Evaporator Fan being off.
kW/ton = Compressor efficiency (kW/ton)
0.285 = Conversion factor, one kW equals 0.285388 ton

$$\Delta kWh\ Comp\_Evap_{ctrl} = (kW_{comp} \times ((FLH_{W}) + (FLH_{s})) \times F_{ctrl}) + (kW_{fan} \times FLH_{fan} \times (1\text{-}F_{off}) \times F_{ctrl})$$

where:

kW_{comp} = Compressor kW ($V_{comp} \times A_{comp} \times \sqrt{Phase}_{comp} \times PF_{comp}$)
V_{comp} = Compressor nameplate volts
A_{comp} = Compressor nameplate amps
$Phase_{comp}$ = Number of phases (1 or 3)
PF_{comp} = Power factor for compressor

FLH_s = Compressor summer FLH = $Cycle_{summer} \times hr_{summer}$
FLH_w = Compressor winter FLH = $Cycle_{winter} \times hr_{winter}$
F_{off} = Fraction of time that Evaporator Fan is turned off.
F_{ctrl} = Fraction of time compressor and fans are off due to electronic controls
A_{comp} = Nameplate Amps of Compressor
V_{comp} = Nameplate Volts of Compressor
$Phase_{comp}$ = Phase of Compressor (1 or 3)

Peak Coincident Demand Savings

$$\Delta kW = kW_{fan} \times DF$$

Summary of Variables and Data Sources

Variable	Value	Notes
PF_{fan}	0.55	National Resource Management (NRM) - Program Implementer
PF_{comp}	0.85	National Resource Management (NRM) - Program Implementer
Op hr	8760	Hours per year
Ton/kW	0.285	Unit conversion
F_{off}	0.352	Estimate by NRM based on downloads of hours of use data from the electronic controller.
kW/ton	1.6	Typical refrigeration system kA/ton
$Cycle_{summer}$	0.55	Average summer duty cycle
Hr_{summer}	6565	Summer season hours/yr
$Cycle_{winter}$	0.35	Average winter duty cycle
Hr_{winter}	2195	Winter season hours/yr
DF	0.228	Based on New England Power Service Co. report "Savings from Walk-In Cooler Air Economizers and Evaporator Fan Controls", HEC, June 28, 1996

Coincident Factor (CF)

The recommended value for the coincident factor is 0.8

Baseline Efficiencies from which Savings are Calculated

The savings from this measure is highly dependent on the type, size and condition of the coolers and freezers fitted with fan controls. As a result, an estimate of the typical unit must be based on the program's projection of what types and sizes of units will be served and the condition of those units to function. In general, this estimate approach must be made for the typical units that the program is expected to control.

Compliance Efficiency from which Incentives are Calculated

Operating Hours

Included in formula above

Effective Useful Life (EUL)

Years: 16
Source: DEER

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. Diversity factor taken from "New England Power Service Co. study of Economizers and Evaporator Fan Controls", HEC, June 28, 1996.

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1	10/15/2010
7-13-16	7/31/2013
1-16-8	1/1/2016

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APPENDIX G

EQUIVALENT FULL-LOAD HOURS (EFLH), FOR HEATING AND COOLING

Analysis used to develop parameters for the energy and demand savings calculations are based on DOE-2.2 simulations of a set of prototypical residential buildings. The prototypical simulation models were derived from the residential building prototypes used in the California Database for Energy Efficiency Resources (DEER)[1] study, with adjustments made for local building practices and climate.

Four separate models were created to represent general vintages of buildings:

1. Built prior to 1940, uninsulated masonry buildings. This vintage is referred to as "Pre-war uninsulated brick "

2. Built prior to 1979 when the NYS Energy Code (known as the Energy Conservation Construction Code of New York State – ECCCNYS) went into effect, poorly insulated wood-frame buildings This vintage is referred to as "Prior to 1979"

3. Built from 1979 through 2006, with insulation conforming to 1980s era building codes (1979 ECCCNYS.) This vintage is referred to as "From 1979 through 2006."

4. Built from 2007 through the present, new construction with insulation conforming to the 2007 ECCCNYS for residential buildings and the New York City Energy Conservative Construction Code (if applicable.) This vintage is referred to as "From 2007 through the present."

[1] 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December 2005. Available at www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

SINGLE-FAMILY DETACHED COOLING EFLH BY VINTAGE AND CITY

City	Old	Average	New
Albany	322	310	279
Binghamton	199	197	158
Buffalo	334	322	276
Massena	258	250	210
Poughkeepsie	496	470	464
NYC	670	649	630
Syracuse	310	296	268

MULTI-FAMILY LOW-RISE COOLING EFLH BY VINTAGE AND CITY

City	Prior to 1979	From 1979 Through 2006	From 2007 Through the Present
Albany	295	286	279
Binghamton	219	217	210
Buffalo	274	270	256
Massena	230	228	218
NYC	562	550	507
Poughkeepsie	421	423	397
Syracuse	297	284	265

MULTI-FAMILY HIGH-RISE COOLING EFLH BY VINTAGE AND CITY[2]

City	Prior to 1979	From 1979 Through 2006	From 2007 Through the Present
Albany	782	647	594
Binghamton	684	539	479
Buffalo	773	637	572
Massena	668	571	532
NYC	954	843	793
Poughkeepsie	812	669	626
Syracuse	845	665	592

[2] Note, there are no cooling values for the “Pre-war uninsulated brick vintage, due to a typical lack of any central cooling. This vintage assumes one room air conditioner (RAC) within the unit. For the savings calculation method, see the Air Conditioner – Room (RAC) measure listed in the Single and Multi-family Residential Measures section of this manual.

Heating equivalent full-load hours for residential buildings were originally calculated from a DOE-2.2 simulation of prototypical residential buildings. The prototype building characteristics are described in Appendix A. The revised heating EFLH are shown below:[3]

SINGLE-FAMILY DETACHED HEATING EFLH BY VINTAGE AND CITY

City	Old	Average	New
Albany	1,042	978	925
Binghamton	1,086	1,029	963
Buffalo	1,072	1,032	957
Massena	1,125	1,061	1,009
NYC	867	786	725
Poughkeepsie	931	862	807
Syracuse	1,098	1,042	972

MULTI-FAMILY LOW-RISE HEATING EFLH BY VINTAGE AND CITY

City	Pre-war uninsulated brick	Prior to 1979	From 1979 Through 2006	From 2007 Through the Present
Albany	1,111	1,030	1,012	729
Binghamton	1,397	1,320	1,245	899
Buffalo	1,281	1,219	1,215	883
Massena	1,433	1,306	1,326	964
NYC[4]	999	757	723	503
Poughkeepsie	857	894	868	616
Syracuse	1,395	1,175	1,206	845

MULTI-FAMILY HIGH-RISE HEATING EFLH BY VINTAGE AND CITY

City	Pre-war uninsulated brick	Prior to 1979	From 1979 Through 2006	From 2007 Through the Present
Albany	975	786	626	363
Binghamton	1,102	1,006	831	484
Buffalo	1,181	966	813	471
Massena	1,111	1,016	873	552
NYC[5]	1,012	526	395	219
Poughkeepsie	922	656	510	291
Syracuse	1,063	889	787	474

[3] The original EFLH numbers have been adjusted according to the recommendations contained in the statewide evaluation performed by Opinion Dynamics, New York Statewide Residential Gas High-Efficiency Heating Equipment Programs – Evaluation of 2009-2011 Programs, August 2014. Recommendations regarding EFLH hours located on page 81.

[4] NYC building only incorporates a higher thermostatic set point of 73°F instead of 70 °F based on reported data. The other cities listed use the thermostatic set-point of 7070^0 F. Overheating in Hot Water and Steam-Heated Multi-family Buildings, U.S. Dept. of Energy, Jordan Dentz, Kapil Varshney and Hugh Henderson, October 2013.

[5] IBID

SMALL COMMERCIAL COOLING EFLH

Building	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Assembly	478	436	497	415	669	574	506
Auto Repair	272	244	264	223	426	302	298
Big Box Retail	769	760	826	688	1279	1024	831
Fast Food Restaurant	512	501	519	436	645	579	544
Full Service Restaurant	437	514	460	389	574	506	466
Grocery	769	760	826	688	1279	1024	831
Light Industrial	400	435	423	370	549	475	429
Motel	734	959	1084	997	1233	1143	1072
Primary School	297	264	244	257	394	346	274
Religious Worship	227	1006	190	204	279	230	246
Small Office	742	714	745	671	955	849	768
Small Retail	642	644	666	599	882	762	678
Warehouse	234	194	212	228	400	284	243
Other	501	572	535	474	736	623	553

LARGE COMMERCIAL COOLING EFLH

Building	System	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Community College	CAV econ	585	433	520	509	846	706	609
	CAV noecon	773	586	693	692	1,128	997	811
	VAV econ	470	376	456	353	658	532	455
Dormitory[6]	Fan Coil*	736	657	752	693	800	760	763
High School	CAV econ	348	304	323	318	466	407	388
	CAV noecon	713	727	741	727	861	787	764
	VAV econ	237	203	215	215	341	289	256
Hospital	CAV econ	1,038	918	1,114	1,038	1,424	1,231	1,147
	CAV noecon	1,728	1,662	1,908	1,730	2,237	1,983	1,906
	VAV econ	961	855	1,026	962	1,217	1,089	1,050
Hotel	CAV econ	2,744	3,078	2,744	2,807	2,918	3,039	3,471
	CAV noecon	2,945	3,270	2,945	3,021	3,108	3,253	3,653
	VAV econ	2,702	3,046	2,702	2,745	2,929	2,937	3,437
Large Office	CAV econ	706	534	587	610	720	713	667
	CAV noecon	1,894	1,786	2,016	1,827	2,250	2,072	2,156
	VAV econ	623	519	504	505	716	670	572
Large Retail	CAV econ	858	721	849	753	1,068	920	858

[6] Dormitories consist of individual rooms with small heating/cooling coils. Constant Air Volume (CAV) or Variable Air Volume (VAV) with Economizers (econ) are not typically used.

Building	System	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
	CAV noecon	1,656	1,613	1,763	1,545	1,751	1,670	1,656
	VAV econ	704	594	713	611	886	757	704
University	CAV econ	680	496	610	567	882	706	699
	CAV noecon	936	723	870	811	1,208	1,030	951
	VAV econ	526	432	518	413	690	568	523

SMALL COMMERCIAL HEATING EFLH

Building	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Assembly	961	1006	990	1158	603	782	903
Auto Repair	3325	3455	3331	3649	1910	2642	3271
Big Box Retail	554	509	557	620	191	373	522
Fast Food Restaurant	1426	1526	1491	1690	813	1120	1351
Full Service Restaurant	1502	1602	1567	1746	821	1162	1419
Grocery	554	509	557	620	191	373	522
Light Industrial	1278	1320	1188	1286	714	996	1200
Motel	1037	787	789	832	619	603	778
Primary School	1300	1290	1357	1311	840	1070	1236
Religious Worship	954	202	978	1015	722	802	962
Small Office	747	793	760	861	431	589	750
Small Retail	984	1006	1020	1134	545	765	969
Warehouse	916	1023	940	1094	452	642	888
Other	1195	1156	1194	1309	681	917	1136

LARGE COMMERCIAL HEATING EFLH

Building	System	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Community College	CAV econ	1,111	1,072	1,047	1,301	1,431	1,171	1,259
	CAV noecon	1,052	1,042	1,006	1,177	1,268	1,050	1,177
	VAV econ	607	1,161	1,040	606	434	389	554
Dormitory*	Fan Coil*	594	678	753	687	465	507	673
High School	CAV econ	776	782	808	822	901	898	960
	CAV noecon	701	725	741	759	840	829	902
	VAV econ	326	300	384	382	268	303	395
Hospital	CAV econ	3,084	2,847	2,897	2,782	3,366	2,886	3,062
	CAV noecon	2,733	2,423	2,516	2,353	3,137	2,514	2,704
	VAV econ	763	766	642	739	296	481	771
Hotel	CAV econ	1,230	1,177	1,220	1,239	1,077	1,054	1,175
	CAV noecon	962	907	941	1,032	753	794	919
	VAV econ	552	482	518	661	229	376	464
Large Office	CAV econ	2,136	2,047	2,020	2,349	2,034	2,142	2,218

Building	System	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
	CAV noecon	2,097	1,965	1,976	2,307	2,072	2,133	2,219
	VAV econ	484	476	485	544	291	367	441
Large Retail	CAV econ	2,167	2,148	2,147	2,243	2,101	2,030	2,144
	CAV noecon	2,057	1,983	2,015	2,106	2,033	1,913	2,030
	VAV econ	859	735	777	927	664	632	783
University	CAV econ	1,464	1,573	1,531	1,589	1,191	1,352	1,390
	CAV noecon	1,439	1,438	1,461	1,456	1,104	1,308	1,356
	VAV econ	1,060	569	1,206	1,224	684	761	624

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0	10/15/2010
6-15-8	6/1/2015
1-16-9	1/1/2016

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APPLIANCE - CONTROL

ADVANCED POWER STRIP

Measure Description
This measure describes savings associated with the use of an Advanced Power Strip (APS) to minimize energy use. An APS makes use of a control plug to disconnect the additional strip regular plugs when the load on the control plug power is reduced below the threshold. Therefore, the overall load of a centralized group of equipment (i.e. entertainment centers and home offices) can be reduced.

Method for Calculating Annual Energy and Peak Coincident Demand Savings
Annual Electric Energy Savings
ΔkWh = units × (Deemed Annual Electric Energy Savings)

Peak Coincident Demand Savings
ΔkW = units × (Deemed Peak Coincident Demand Savings) × CF

Annual Gas Energy Savings
Δtherms = N/A

Deemed Annual Electric Energy Savings
5-plug Tier 1 - Advanced Power Strip - 56.5 kWh
6-plug Tier 1 - Advanced Power Strip - 80.0 kWh
7-plug Tier 1 - Advanced Power Strip - 102.8 kWh

Deemed Peak Coincident Demand Savings
5-plug Tier 1 - Advanced Power Strip - 0.0063 kW
6-plug Tier 1 - Advanced Power Strip - 0.0089 kW
7-plug Tier 1 - Advanced Power Strip - 0.012 kW

where:
ΔkWh = annual energy savings
ΔkW = coincident demand savings
Δtherms = annual gas energy savings
units = the number of units installed
CF = coincidence factor

Summary of Variables and Data Sources
This measure characterization provides savings for a 5-plug, 6-plug, and a 7-plug strip.

Variable	Value	Notes
ΔkWh	56.5 kWh	5-plug tier-1 power strip
ΔkWh	80.0 kWh	6-plug tier-1 power strip
ΔkWh	102.8 kWh	7-plug tier-1 power strip

Coincidence Factor (CF)
The recommended value for the coincidence factor is 0.0

Baseline Efficiencies from which Savings are Calculated
Baseline case assumes no control of electronics.

Compliance Efficiency from which Incentives are Calculated
Efficient Case is a 5, 6 or 7 plug strip with a control plug in use.

Description of Advanced Power Strip (APS) tiered technology:

APS Tier 1 technology differs from standard power strips due to APS's three distinctive sockets: switched, control and always on. All electronics in the "switched" socket (e.g. home theater, DVD player, stereo, printer, etc.) are shut down when the "control' device (e.g. television, game console, computer) is turned off. Separate from the control and switched sockets, the APS has spaces for devices that need to be "always on" (e.g. clock, cable box, etc.). Reducing the standby power with APS devices would have an immediate effect on the large percentage of wasted energy.

Tier 2 APS products also address active power consumption. APS Tier 2 technology has the capacity to reduce active energy by sensing when consumers are not using a device. Therefore, despite Tier 2 APS products recently entering the market, they have a higher savings potential than Tier 1 APS products.

Operating Hours
Annual hours when controlled standby loads are turned off is 7,149

Effective Useful Life (EUL)
Years: 4 years
Source: NEEP Mid-Atlantic Technical Reference Manual V2.0 July 2011

Ancillary Annual Fossil Fuel Savings Impact – N/A

Ancillary Annual Electric Savings Impact – N/A

References

1. NEEP Mid-Atlantic Technical Reference Manual V2.0 July 2011

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1-16-10	1-1-2016

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LIGHTING - CONTROL

BI-LEVEL LIGHTING

Measure Description

Stairwell Bi-Level lighting fixtures provide lighting to spaces that are infrequently used, such as stairwells, where a minimum level of illumination is desired when unoccupied and a higher level when occupied. These fixtures are controlled by an integral occupancy sensor and are customarily available as replacements for existing fixtures. These fixtures are available with both fluorescent and LED lamps. Light levels are adjustable from 10% to 100% of nominal light output and are also available with battery back up to provide minimally code compliant illumination for a period of ninety minutes. These fixtures, when installed as a replacement fixture, provide electrical savings without compromising safety.

Method for Calculating Annual Energy Savings and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units\ x\ [(\frac{Wexist}{1000}\ x\ 8760) - ((\frac{Woc}{1000}\ xFLHoc\ ) + (\frac{Wun}{1000})\ x\ FLHun\ ))]$$

Peak Coincident Demand Savings

$$\Delta kW = units\ x\ [(\frac{Wexist}{1000} - \frac{Woc}{1000}) + ((\frac{Woc - Wun}{1000})\ x\ (\frac{FLHun}{8760}))]\ x\ CF$$

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
W_{exist}	= Wattage of the baseline unit
W_{oc}	= Wattage of the energy efficient fixture when occupied
W_{un}	= Wattage of the energy efficient fixture when unoccupied
FLH	= Full Load Hours of the baseline unit
FLH_{oc}	= Full Load Hours of energy efficient fixture when occupied
FLH_{un}	= Full Load Hours of energy efficient fixture when unoccupied (standby)
CF	= Coincidence Factor
8760	= Conversion Factor, Hours to Year

Summary of Variables and Data Source

Variables	Value	Notes
units		From application, invoices or other documentation. Equal to number of lamps installed and operating.
W_{exist}		From application, connected load of existing unit.
W_{oc}		From application, connected load of the energy efficient unit when occupied.
W_{un}		From application, connected load of the energy efficient unit when unoccupied (standby).
FLH_{oc}	438 hours	Full Load Hours of energy efficient fixture when occupied.
FLH_{un}	8,322 hours	Full Load Hours of energy efficient fixture when unoccupied (standby).

Coincidence Factor (CF)

As stairwell lighting is required for life safety at all times in accordance with regulations the coincidence factor is assumed to be 1.0.

Operating Hours

Based on market research the stairwells are occupied only 5% of the time. Therefore 95% of the time the new fixture will be in the reduced wattage mode.

Reduced Wattage

Bi-level fixture from the leading lighting manufactures produce lights that will reduce the capacity to 33% or below during the unoccupied mode, when actual fixture data is not available assume that during the unoccupied mode the rated wattage will be reduced by 50%.

Effective Useful Life (EUL)

See Appendix P: Effective Useful Life (EUL)

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. Field Test DELTA Snapshots with Staff and NYSERDA inputs. Staircase Lighting Sponsored by LaMar Lighting and NYSERDA. March 2004.

2. The 33% unoccupied mode capacity is based on actual lighting specifications of installed fixtures with Staff and NYSERDA inputs. The 50% unoccupied mode capacity is based on the common bi-level application where one of two bulbs in the fixture is turned off during the unoccupied mode.

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1-16-11	1/1/2016

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THERMOSTATIC RADIATOR VALVE – ONE PIPE STEAM RADIATOR

Measure Description

Thermostatic Radiator Valves (TRV) are self-contained, self-operated valves that do not require ancillary power. They provide local control of room temperature by regulating the flow of hot water or steam to free-standing radiators, convectors, or baseboard heating units. TRV are available for a variety of installation conditions utilizing either remote-mounted sensors or integral-mounted sensors by means of remote or integral set point adjustment. This measure is specifically a TRV in combination with an air vent installed at one or more radiators in a one-pipe steam space heating system.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta \text{kWh} = \text{N/A}$$

Peak Coincident Demand Savings

$$\Delta \text{kW} = \text{N/A}$$

Annual Gas Energy Savings

$$\Delta \text{therms} = \text{Units} \times \Delta \text{therms/HDD} \times \text{HDD}_{avg}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
units	= Number of TRV's installed
Δtherms/HDD	= Annual gas energy savings per Heating Degree Day (HDD), per TRV
HDD_{avg}	= Average Heating Degree Days

Summary of Variables and Data Sources

Variable	Value	Notes
units		Number of TRV's installed, from application
Δ Therms/HDD	0.004318	Average gas savings per HDD per unit[1]
HDD_{avg}	4805	Heating Degree Days for New York City[2]

[1] Thermostatic Radiator Valve (TRV) Demonstration Project . Prepared by NYSERDA, Project manager Norine Karins and the EME Group project manager Michael McNamara. NYSERDA report 95-14. September 1995.

[2] 2009 International Energy Conservation Code, Table D-1, US & US Territory Climate Data

Coincidence Factor (CF)

N/A

Baseline Efficiencies from which Savings are Calculated

The baseline condition is an existing space heating system with manual control valves at free-standing radiators, convectors, or baseboard heating units.

Compliance Efficiency from which Incentives are Calculated

The measure is defined as the existing radiator, convector, or baseboard heater unit controlled by the thermostatic radiator valve.

Operating Hours

N/A

Effective Useful Life (EUL)

Years: 12
Source: NYS DPS

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. Thermostatic Radiator Valve (TRV) Demonstration Project. Prepared by NYSERDA, Project manager Norine Karins and the EME Group project manager Michael McNamara. NYSERDA report 95-14. September 1995.
2. 2009 International Energy Conservation Code, Table D-1, US & US Territory Climate Data.

Record of Revision

Record of Revision Number	Issue Date
1-16-12	1/1/2016

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ENERGY MANAGEMENT SYSTEM (EMS)

Measure Description

An Energy Management System (EMS) is a computer system designed specifically for the automated control and monitoring of building systems which optimize the use of energy, as consumed by heating, ventilation, air conditioning, and domestic hot water heating. An EMS operates building functions as efficiently as possible while maintaining a specified level of comfort through the use of electro-mechanical control mechanisms. In multifamily buildings, an EMS installed with indoor temperature sensors in apartments and other heated spaces can reduce energy consumption by optimizing boiler operation based on seasonal weather variations, use patterns, and self-diagnostic functions. The measure is defined as the installation of a new EMS, consisting of a central boiler control system that allows for staging/control of multiple boilers and monitors indoor temperature, stack temperature, outdoor temperature, and supply or return water temperature.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = N/A$$

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

$$\Delta therms = \frac{BTUh_{in}}{100{,}000} \times EFLH_{heating} \times ESF$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
$\Delta therms$ = Annual gas energy savings
$BTUh_{in}$ = Furnace or boiler input rating
$EFLH_{heating}$ = Equivalent full-load hours
ESF = Energy Savings Factor for EMS
100,000 = Conversion factor, (BTUh/Therm)

Summary of Variables and Data Sources

Variable	Value	Notes
$BTUh_{in}$		From application, furnace or boiler input rating, in Btu/hr.
$EFLH_{heating}$		Lookup based on building type and location.
ESF	0.22	Energy Savings Factor, from US Energy Group study[1]

[1] Thermostatic Radiator Valve (TRV) Demonstration Project . Prepared by NYSERDA, Project manager Norine Karins and the EME Group project manager Michael McNamara. NYSERDA report 95-14. September 1995.

Coincidence Factor (CF)

N/A

Baseline Efficiencies from which Savings are Calculated

The baseline condition is an existing boiler control system based on outdoor temperature reset.

Compliance Efficiency from which Incentives are Calculated

The measure is defined as the new installation of a complete EMS with the capability of controlling an existing boiler system based on indoor and outdoor temperature.

Operating Hours

Heating equivalent full-load hours were calculated from a DOE-2.2 simulation of prototypical small commercial buildings. The EFLH values for commercial buildings are identified in Appendix G.

Effective Useful Life (EUL)

Years: 15
Source: DEER

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. US Energy Group Case Study #241, prepared by Sherri Jean Katz.

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1-16-13	1/1/2016

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ELECTRONICALLY CONTROLLED BRUSHLESS PERMANENT MAGNET (BPM) MOTORS FOR HVAC CIRCULATION (BLOWER) FAN

Measure Description

Electronically Controlled Brushless Permanent Magnet Motors, also commonly referred to as electronically commutated motors provide increased efficiency by using a micro-processor to obtain variable speed response and improve both efficiency and reliability by means of eliminating friction attributable to brushes. While such technology has been available for some time and available to a wide variety of applications such motors are now being widely adopted by HVAC equipment manufacturers and contractors as a substitute for existing permanent-split capacitor motors. This measure addresses the specific application of BPM motors on a retro-fit basis for circulating fans of one Horsepower (HP) or less in HVAC air distribution equipment employing heating and/or cooling.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta \text{kWh} = \Delta \text{kWh}_{\text{heat}} + \Delta \text{kWh}_{\text{cool}}$$

Electric Energy Savings during Cooling Season

$$\Delta \text{kWh}_{\text{cool}} = \frac{\left(\text{W}_{\text{psc}} \text{ x } \Delta \text{W}_{\text{cool}}\right)}{1000} \times \text{LF} \times \text{EFLH}_{\text{cool}} \times (1 + \text{HVAC}_{\text{c}})$$

Electric Energy Savings during Heating Season

$$\Delta \text{kWh}_{\text{heat}} = \frac{\left(\text{W}_{\text{psc}} \text{ x } \Delta \text{W}_{\text{heat}}\right)}{1000} \times \text{LF} \times \text{EFLH}_{\text{heat}} \times (1 + \text{HVAC}_{\text{c}})$$

Peak Coincident Demand Savings

$$\Delta \text{kW}_{\text{cool}} = \frac{\left(\text{W}_{\text{psc}} \text{ x } \Delta \text{W}_{\text{cool}}\right)}{1000} \times \text{LF} \times \text{CF} \times (1 + \text{HVAC}_{\text{d}})$$

where:

ΔkWh	= Annual electric energy savings
ΔkWh_{cool}	= Electric energy savings during cooling season
ΔkWh_{heat}	= Electric energy savings during heating season
$\Delta \text{kW}_{\text{cool}}$	= Peak coincident demand savings
W_{psc}	= Baseline PSC motor wattage
$\Delta \text{W}_{\text{heat}}$	= Energy efficient BPM motor wattage percentage savings, heating season[1]
$\Delta \text{W}_{\text{cool}}$	= Energy efficient BPM motor wattage percentage savings, cooling season[1]
LF	= Motor load factor
CF	= Coincidence factor
$\text{EFLH}_{\text{heat}}$	= Equivalent full load hours during heating season
$\text{EFLH}_{\text{cool}}$	= Equivalent full load hours during cooling season
HVAC_{c}	= HVAC interactive effects multipliers for annual electric energy consumption
HVAC_{d}	= HVAC interactive effects multipliers at summer utility peak hour

Summary of Variables and Data Sources

Variable	Value	Notes
W_{psc}	# Watts	Baseline PSC Motor Wattage Nameplate Data or Default Motor Wattage Value Table
ΔW_{heat}	23%	Energy Efficient BPM Motor Wattage Percentage Savings During Heating Season[1]
ΔW_{cool}	38%	Energy Efficient BPM Motor Wattage Percentage Savings During Cooling Season[1]
LF	0.9	Default Value
CF	0.8	Default Value
$EFLH_{heat}$	# Hours	Appendix G: Equivalent Full Load Hours
$EFLH_{cool}$	# Hours	Appendix G: Equivalent Full Load Hours
$HVAC_c$	#	Appendix D: HVAC Interactive Effects
$HVAC_d$	#	Appendix D: HVAC Interactive Effects Multipliers at Summer Utility Peak Hour
HP	#	Motor Rated Horsepower

Circulation Fan Default Motor Wattage Value Table

Motor Type	Motor Category (Default Output Watts [2])				
	1/6 HP	1/4 HP	1/3 HP	½ HP	3/4 HP
PSC Motor	311	403	460	713	1150

Coincidence Factor (CF)
The recommended coincidence factor for this measure is 0.8 consistent with all commercial air conditioning applications.

Baseline Efficiencies from which Savings are Calculated
The baseline condition is a standard efficiency PSC motor.

Compliance Efficiency from which Incentives are Calculated
The measure is defined as a BPM motor of equivalent HP.

Operating Hours
See Appendix G: Equivalent Full Load Hours for both Heating and Cooling Season Operating Hours.

Effective Useful Life (EUL)
Years: 15
Source: Appendix P: Effective Useful Life

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. *Evaluation of Retrofit Variable-Speed Furnace Fan Motors*, R. Aldrich and J. Williamson, Consortium for Advanced Residential Buildings, U.S. Department of Energy Building Technologies Office, January 2014
2. NIDEC Motor Corporation, Residential and Commercial HVACR Standard Motor Catalog, 2015

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1-16-14	1-1-2016

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APPLIANCE RECYCLING

AIR CONDITIONER – ROOM (WINDOW) AIR CONDITIOER RECYCLING

Measure Description

Room (Window) Air Conditioners, a consumer (appliance) product, other than a "packaged terminal air conditioner," which is powered by a single-phase electric current and is an encased assembly designed as a unit for mounting in a window or through the wall for the purpose of providing delivery of conditioned air to an enclosed space. It includes a prime source of refrigeration and may include a means for ventilating and heating.[1] Minimum energy conservation standards for these appliances have been established by the Code for Federal Regulations 10 CFR 430.32(b). As this standard continues to be revised, and by association Energy Star standards continue to increase, operational savings attributable to new RAC may justify early retirement before the full useful life has been exhausted. In order to realize the anticipated savings, a currently functioning appliance of equivalent cooling capacity and type having been manufactured before June 2014 must be properly disposed of when a new appliance is supplied to the customer.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings, Method using EER

$$\Delta \mathrm{kWh} = \frac{\mathrm{Capacity}}{1{,}000} \times \left(\frac{1}{\mathrm{EER_{base}}} - \frac{1}{\mathrm{EER_{ee}}}\right) \times \mathrm{EFLH_{cooling}}$$

Annual Electric Energy Savings, Alternate Method using CEER[2]

$$\Delta \mathrm{kWh} = \frac{\mathrm{Capacity}}{1{,}000} \times \left(\frac{1}{\mathrm{CEER_{base}}} - \frac{1}{\mathrm{CEER_{ee}}}\right) \times \mathrm{EFLH_{cooling}}$$

Peak Coincident Demand Savings, Method using EER

$$\Delta \mathrm{kW} = \frac{\mathrm{Capacity}}{1{,}000} \times \left(\frac{1}{\mathrm{EER_{base}}} - \frac{1}{\mathrm{EER_{ee}}}\right) \times \mathrm{CF}$$

Peak Coincident Demand Savings, Alternate Method using CEER[2]

$$\Delta kW = \frac{\mathrm{Capacity}}{1{,}000} \times \left(\frac{1}{\mathrm{CEER_{base}}} - \frac{1}{\mathrm{CEER_{ee}}}\right) \times \mathrm{CF}$$

Annual Gas Energy Savings

Δtherms = N/A

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[1] Energy Star® Program Requirements, Product Specification for Room Air Conditioners, Eligibility Criteria Version 3.1

[2] When available the Combined Energy Efficiency Rato should be used for the purpose of calculating annual electrical energy savings.

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
Capacity	= Cooling output rating, in BTU/hr
$EFLH_{cooling}$	= Cooling Equivalent Full-Load Hours
CF	= Coincidence Factor
CEER	= Combined Energy Efficiency Ratio
EER	= Energy Efficiency Ratio
ee	= Energy efficient condition or measure
baseline	= Baseline condition or measure
1,000	= Conversion factor (1,000 Watts / Kilowatt)

Packaged Terminal Air Conditioner (PTAC) is defined as a wall sleeve and a separate unencased combination of heating and cooling assemblies specified by the builder and intended for mounting through the wall.

RAC with louvered sides have exterior side vents to facilitate airflow over the outdoor coil.

RAC with reverse cycle are appliances that may reverse the refrigeration cycle so as to serve as heating equipment, also known as a heat pump.

Summary of Variables and Data Sources

Variable	Value	Notes
Capacity		From application.
$EFLH_{cooling}$		Cooling equivalent full-load hours by building type, Appendix G.
$CEER_{baseline}$		From application, or lookup from table below based on unit capacity when unknown.
$CEER_{ee}$		From application.
$EER_{baseline}$		From application, or lookup from table below based on unit capacity when unknown.
EER_{ee}		From application.

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8

Baseline Efficiencies from which Savings are Calculated

Baseline efficiency assumptions for normal replacement of units manufactured between the years 2000 - 2014. Baseline efficiency of air conditioners manufactured after June 2014 will be the compliance efficiency.

Room Air Conditioners

Capacity (BTU/hr)	with Louvered Sides (EER_{base})	without Louvered Sides (EER_{base})
< 6,000	≤ 9.7	≤ 9.0
6,000 - 8,000	≤ 9.7	≤ 9.0
8,000 – 13,999	≤ 9.8	≤ 8.5
14,000 – 19,999	≤ 9.7	≤ 8.5
20,000– 24,999	≤ 8.5	≤ 8.5
≥ 25,000	≤ 8.5	≤ 8.5

Room Air Conditioners - Casement

Capacity (BTU/hr)	Casement Only (EER_{base})	Casement - Slider (EER_{base})
All	≤ 8.7	≤ 9.5

Room (Air Conditioners with Reverse Cycle) Heat Pumps

Capacity (BTU/hr)	with Louvered Sides (EER_{base})	without Louvered Sides (EER_{base})
< 6,000	≤ 9.0	≤ 8.5
6,000 - 8,000	≤ 9.0	≤ 8.5
8,000 – 13,999	≤ 9.0	≤ 8.5
14,000 – 19,999	≤ 9.0	≤ 8.0
≥ 20,000	≤ 8.5	≤ 8.0

Compliance Efficiency from which Incentives are Calculated

Units will be treated as early retirement and total lifetime energy savings will be calculated based on remaining years of useful life (RUL) of the existing baseline unit. Units greater than 15 years old will be considered normal replacements and will be given incremental savings. Incremental savings are defined as the difference between the annual kWh consumption of minimally compliant with Federal appliance standards and the annual kWh consumption of the new unit.

Room Air Conditioners

Capacity (BTU/hr)	with Louvered Sides (EER_{ee})	withouot Louvered Sides (EER_{ee})
< 6,000	≥ 11.0	≥ 10.0
6,000 - 8,000	≥ 11.0	≥ 10.0
8,000 – 13,999	≥ 10.9	≥ 9.6
14,000 – 19,999	≥ 10.7	≥ 9.5
20,000– 24,999	≥ 9.4	≥ 9.3
≥ 25,000	≥ 9.0	≥ 9.4

Room Air Conditioners - Casement

Capacity (BTU/hr)	Casement Only (EER_{ee})	Casement - Slider (EER_{ee})
All	≤ 9.5	≤ 10.4

Room (Air Conditioners with Reverse Cycle) Heat Pumps

Capacity (BTU/hr)	with Louvered Sides (EER_{ee})	withouot Louvered Sides (EER_{ee})
< 6,000	≤ 9.8	≤ 9.3
6,000 - 8,000	≤ 9.8	≤ 9.3
8,000 – 13,999	≤ 9.8	≤ 9.3
14,000 – 19,999	≤ 9.8	≤ 8.7
≥ 20,000– 24,999	≤ 9.3	≤ 8.7

Operating Hours

Refrence Apendix G for applicable value for specific building use type and geographic location.

Effective Useful Life (EUL)

Years: 15
Source: 2005 DEER

Remaining Useful Life (RUL)

RUL = 15 year – (2014 – Year Manufactured)

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. EFLH taken from Coincidence Factor Study Residential Room Air Conditioners, conducted by RLW Analytics, 2008.
    a. neep.org/.../2008-6-23_Final_Report_Coincidence_Factor_Study_Residential_Room_Air_Conditioners_SPWG.pdf
2. Replacement factor taken from the Nexus Market Research. December 2005. Impact Process and Market Study of the Connecticut Appliance Retirement Program: Overall Report. Cambridge, Mass.: Nexus Market

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1-16-15	1/1/2016

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REFRIGERATION

FREEZER AND COOLER DOOR STRIP CURTAIN

Measure Description

Strip Curtains on both freezers (AKA low temperature) or coolers (AKA medium temperature) refrigerated walk-in units serve to prevent air infiltration during periods when the main door is open for routine stocking activity. When damaged and/or missing the warmer, more humid air, present in the store will infiltrate the unit increasing the demands on the electrical energy consumed by the refrigeration system and often reducing the efficiency of the evaporator unit as frost accumulates impairing its effectiveness. This measure applies to strip curtains on the main door of walk-in units typical of supermarkets, convenience stores, and restaurants.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta \mathrm{kWh}_{\mathrm{cooler}} = \mathrm{SF}_{\mathrm{door}} \times \Delta \mathrm{kWh}_{\mathrm{cooler,per\ SF}}$$

$$\Delta \mathrm{kWh}_{\mathrm{freezer}} = \mathrm{SF}_{\mathrm{door}} \times \Delta \mathrm{kWh}_{\mathrm{freezer,per\ SF}}$$

Peak Coincident Demand Savings

$$\Delta \mathrm{kW}_{\mathrm{cooler}} = \mathrm{SF}_{\mathrm{door}} \times \frac{\Delta \mathrm{kWh}_{\mathrm{cooler,per\ SF}}}{8760} \times \mathrm{CF}$$

$$\Delta \mathrm{kW}_{\mathrm{freezer}} = \mathrm{SF}_{\mathrm{door}} \times \frac{\Delta \mathrm{kWh}_{\mathrm{freezer,per\ SF}}}{8760} \times \mathrm{C}F$$

Annual Gas Energy Savings

N/A

where:

ΔkWh$_{cooler}$	= Annual electric energy savings for cooler
ΔkWh$_{freezer}$	= Annual electric energy savings for freezer
ΔkW$_{cooler}$	= Peak coincident electrical demand savings for cooler
ΔkW$_{freezer}$	= Peak coincident electrical demand savings for freezer
ΔkWh$_{cooler, per SF}$	= Annual electric energy savings per square foot of cooler door opening
ΔkWh$_{freezer, per SF}$	= Annual electric energy savings per square foot of freezer door opening
CF	= Coincidence Factor
SF$_{door}$	= Area of cooler or freezer door opening, in square feet
8,760	= Annual cooler or freezer operating hours per year

Summary of Variables and Data Sources

Variable	Value	Notes
$\Delta kWh_{cooler, per SF}$	159 kWh/SF	Supermarket, Annual Energy Savings Attributable to Replacement Strip Curtains at a Cooler ($\geq$ 32° F)
	18 kWh/SF	Restaurant, Annual Energy Savings Attributable to Replacement Strip Curtains at a Cooler ($\geq$ 32° F)
	14 kWh/SF	Convenience Store, Annual Energy Savings Attributable to Replacement Strip Curtains at a Cooler ($\geq$ 32° F)
$\Delta kWh_{freezer, per SF}$	409 kWh/SF	Supermarket, Annual Energy Savings Attributable to Replacement Strip Curtains at a Freezer (< 32° F)
	77 kWh/SF	Restaurant, Annual Energy Savings Attributable to Replacement Strip Curtains at a Freezer (< 32° F)
	16 kWh/SF	Convenience Store, Annual Energy Savings Attributable to Replacement Strip Curtains at a Freezer (< 32° F)
CF	0.8	Default Value
SF_{door}	# SF	The entire area of the main door opening expressed as Square Feet

Coincidence Factor (CF)
The recommended coincidence factor for this measure is 0.8 consistent with all commercial air conditioning applications.

Baseline Efficiencies from which Savings are Calculated
The baseline efficiency is premised on a door with damaged and or missing strip curtains in excess of 15% of the door area.

Compliance Efficiency from which Incentives are Calculated
The compliance efficiency is premised on the replacement of the entire door strip curtain

Operating Hours
Operational hours in which the door is open is the primary determinant of associated savings and therefore the different patterns established by supermarkets, convenience stores, and restaurants each utilize a unique value.

Effective Useful Life (EUL)
Years: 4
Source: ADM Evaluation

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. ADM Associates, Inc. "Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation" February 18, 2010, California Public Utilities Commission Energy Division http://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf\

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REFRIGERATION – FREEZER AND COOLER DOOR GASKETS

Measure Description

Door Gaskets on both freezers (AKA low temperature) or coolers (AKA medium temperature) refrigerated reach-in display cases are subject to damage due to normal use and/or the failure of anti-condensate heater elements. When damaged and/or missing the warmer, more humid air, present in the store will infiltrate the case increasing the demands on the electrical energy consumed by the refrigeration system and often reducing the efficiency of the evaporator unit as frost accumulates impairing its effectiveness. This measure applies to gaskets on both reach-in doors and the main door of walk-in units typical of supermarkets, convenience stores, and restaurants.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh_{cooler} = LF_{door} \times \Delta kWh_{cooler,per\ LF}$$

$$\Delta kWh_{freezer} = LF_{door} \times \Delta kWh_{freezer,per\ LF}$$

Peak Coincident Electric Demand Savings

$$\Delta kW_{cooler} = LF_{door} \times \frac{\Delta kWh_{cooler,per\ LF}}{8760} \times CF$$

$$\Delta kW_{freezer} = LF_{door} \times \frac{\Delta kWh_{freezer,per\ LF}}{8760} \times CF$$

Annual Gas Energy Savings

N/A

where:

ΔkWh_{cooler} = Annual electric energy savings for cooler
$\Delta kWh_{freezer}$ = Annual electric energy savings for freezer
$\Delta kWh_{cooler,\ per\ LF}$ = Annual electric energy savings for cooler door gasket per foot
$\Delta kWh_{freezer,\ per\ LF}$ = Annual electric energy savings for freezer door gasket per foot
ΔkW_{cooler} = Peak coincident electrical demand savings for cooler
$\Delta kW_{freezer}$ = Peak coincident electrical demand savings for freezer
CF = Coincidence Factor
LF_{door} = Linear Feet Damaged / Missing Door Gasket

Summary of Variables and Data Sources

Variable	Value	Notes
ΔkWh_{cooler}	20 kWh/Linear Foot	Annual Energy Savings Attributable to Replacement Door Gasket at a Cooler ($\geq$ 32° F), Missing / Damaged Weighted Average[1]

$\Delta kWh_{freezer}$	152 kWh/Linear Foot	Annual Energy Savings Attributable to Replacement Door Gasket at a Freezer (< 32° F), Missing / Damaged Weighted Average[1]
CF	0.8	Default Value
LF_{door}	# LF	Length of Damaged or Missing Gaskets expressed as Linear Feet

Coincidence Factor (CF)

The recommended coincidence factor for this measure is 0.8 consistent with all commercial air conditioning applications.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency is premised on a door with damaged and or missing gaskets. A weighted average is used to proportion energy savings between both these conditions premised on the survey results conducted by the referenced study, Table 5-4.

Compliance Efficiency from which Incentives are Calculated

The compliance efficiency is premised on the replacement of the entire door gasket so as to achieve a minimum 1.5% or less infiltration rate.

Operating Hours
N/A

Effective Useful Life (EUL)
Years: 4
Source: ADM Evaluation

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. ADM Associates, Inc. “Commercial Facilities Contract Group 2006-2008 Direct Impact Evaluation” February 18, 2010, California Public Utilities Commission Energy Division http://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf\

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1-16-17	1-16-2016

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LOW- FLOW PRE-RINSE SPRAY VALVE

Measure Description

Pre-Rinse Spray Valves (PRSV) —often used in commercial and institutional kitchens—are designed to remove food waste from dishes prior to dishwashing. Retrofitting existing standard PSRV's in locations where service water is supplied by electric or natural gas fired hot water heaters with new low flow pre-rinse spray nozzles reductions in hot water consumption result in corresponding fuel savings.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta\text{kWh} = \text{units} \times ((\text{GPM}_{\text{baseline}} - \text{GPM}_{\text{ee}}) \times 60) \times \text{hrs}_{\text{op}} \times (\text{T}_{\text{heater}} - \text{T}_{\text{main}}) \times \left(\frac{8.33\ \text{lb}}{1\ gal} \times \frac{1\ \text{BTU}}{lb°\text{F}} \times \frac{1\ \text{kWh}}{3412\ BTU} \right) \times \frac{1}{EF_{\text{ele}}}$$

Peak Coincident Electrical Demand Savings

ΔkW = kW x 0.3

Annual Gas Energy Savings

$$\Delta\text{therms} = \text{units} \times ((\text{GPM}_{\text{baseline}} - \text{GPM}_{\text{ee}}) \times 60) \times \text{hrs}_{\text{op}} \times (\text{T}_{\text{heater}} - \text{T}_{\text{main}}) \times \left(\frac{8.33\ \text{lb}}{1\ gal} \times \frac{1\ \text{BTU}}{lb°\text{F}} \times \frac{1\ \text{Therm}}{100{,}000\ BTU} \right) \times \frac{1}{EF_{\text{gas}}}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
kW	= Rated wattage of electrical water heater
Δtherms	= Annual gas energy savings
units	= Number of PRSV installed
$\text{GPM}_{\text{baseline}}$	= Gallons per minute for the baseline condition
GPM_{ee}	= Gallons per minute for the energy efficient measure
hrs_{op}	= Operating hours
T_{heater}	= Water temperature at PRSV output, default value 130°F
T_{main}	= Average water supply input temperature, see table
EF_{gas}	= Gas fired water heater efficiency, energy factor
EF_{ele}	= Electric water heater efficiency, energy factor
0.3	= Confidence Factor, proportionate to reduced water consumption ($\frac{\text{GPM}_{\text{baseline}} - \text{GPM}_{\text{ee}}}{\text{GPM}_{\text{baseline}}}$)
8.33	= Energy required (BTU's), to heat one gallon of water by one degree Fahrenheit
60	= Conversion factor, Minutes to Hour
3,412	= Conversion factor, one kW equals 3,412 BTU/h
100,000	= Conversion factor (BTU/therm), one therm equals 100,000 BTU's

Summary of Variables and Data Sources

Variable	Value	Notes
units	#	From application, quantity of PRSV's installed
$GPM_{baseline}$	1.6	PRSV Minimum Standard[1] effective 2006
GPM_{ee}	1.12	LF PRSV GPM default value
T_{heater}	130	Average water temperature output at the PRSV
T_{main}	#	Average Water Supply Input Temperature
EF_{ele}	#	Electric Efficiency Factor, see Table
EF_{gas}	#	Gas Efficiency Factor, see Table

Average Water Supply Input Temperature

City	Annual average outdoor temperature (°F)	T main (°F)
Albany	48.2	54.2
Binghamton	46.9	52.9
Buffalo	48.3	54.3
Massena	44.7	50.7
Syracuse	48.6	54.6
Upstate average	47.3	53.3
Long Island	56.5	62.5
NYC	56.5	55.0

Current Minimum Federally Mandated Efficiency Energy Factors (Manufactured AFTER April 16, 2015)

Rated Storage Volume	'Tankless"	30	40	50	65	80	120
Gas	.82	.63	.62	.60	.75	.75	.74
Electric	.95	.95	.95	.95	1.98	1.97	1.92

Current Minimum Federally Mandated Efficiency Energy Factors (Manufactured BETWEEN January 20,2004 and April 16, 2015)

Rated Storage Volume	20	30	40	50	65	80	120
Gas	.62	.61	.62	.60	.75	.75	.74
Electric	.94	.93	.92	.90	.88	.86	.81

Coincidence Factor (CF)

The recommended coincidence factor for this measure is 0.8.

Baseline Efficiencies from which Savings are Calculated

The baseline condition is a standard efficiency PRSV.

[1]Energy Policy Act of 2005 (EPAct 2005).

Compliance Efficiency from which Incentives are Calculated
The measure is defined as a Low Flow PRSV with a maximum flow rate of 1.12 GPM.

Operating Hours

Type of Dishwasher	hrs_{op} (Hours/Year) [2]
Pot Washing Sink	726
Door Unit	1,452
Conveyor Unit	2,178

Effective Useful Life (EUL)
Years: 5
Source: GDS

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. Energy Policy Act of 2005 (EPAct 2005).
2. Pacific Gas & Electric workpaper, H101 & H102 Pre-Rinse Spray Valves, February 2005.

Record of Revision

Record of Revision Number	Issue Date
1-16-18	1-1-2016

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[2]Pacific Gas & Electric workpaper, H101 & H102 Pre-Rinse Spray Valves, February 2005.

THERMOSTAT

PROGRAMMABLE SETBACK (NON-COMMUNICATING) AND WIFI (COMMUNICATING)

MEASURE DESCRIPTION

This section covers programmable setback thermostats (non-communicating) and Wi-Fi communicating thermostats applied to single-family and multi-family residential air conditioners, heat pumps, boilers, furnaces and electric resistance baseboard heating systems.

THERMOSTAT – PROGRAMMABLE SETBACK (NON-COMMUNICATING)

Measure Description

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

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings

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

Peak Coincident Demand Savings

$$\Delta kW = N/A$$

Annual Gas Energy Savings

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

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
$\Delta therms$ = Annual gas energy savings
units = The number of air conditioning units installed under the program
tons/unit = Tons of air conditioning per unit, based on nameplate data
SEER = Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, (used for average U.S. location/region)seasonal average energy efficiency ratio (BTU/watt-hour)
12 = kBTUh/ton of air conditioning capacity
100 = Conversion factor, kBTUh/therm
$F_{heating}$ = Energy factor for heating

$F_{cooling}$ = Energy factor for cooling
$kBTUh_{out}$ = Annual gas output rating
$kBTUh_{in}$ = Annual gas input rating
HSPF = Heating seasonal performance factor
EFLH = Equivalent full-load hours
$_{heating}$ = Heating
$_{cooling}$ = Cooling

Summary of Variables & Data Sources

Variable	Value	Notes
tons		From application or use 3 as default. Use 0 if no central cooling
$SEER_{baseline}$	10	
$EFLH_{cooling}$		Vintage weighted average by city.
$F_{cooling}$	0.09	Energy factor for cooling
$EFLH_{heating}$		Vintage weighted average by city.
$F_{heating}$	0.068	Energy factor for heating
If heat pump:		
$kBTUh/unit_{out}$		From application or use 70 kBTU/hr as default
$HSPF_{baseline}$	6.8	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)
if furnace		
$kBTUh_{in}/unit$		From application or use 90 kBTU/hr as a default. Use wt average of furnace and boiler if system type unknown.
if boiler		
$kBTUh_{in}/unit$		From application or use 110 kBTU/hr as default. Use wt average of furnace and boiler if system type unknown.
If resistance heater		
$kBTUh_{in}/unit$		From application or use 12 kBTU/hr (3.5 kW) as default
$HSPF_{baseline}$	3.412	Equivalent to COP = 1

The nominal rating of the cooling capacity of the air conditioner or heat pump should set equal to the rated capacity of all cooling equipment controlled by a setback thermostat in the home. The energy savings should be calculated per residence rather than per thermostat.

The nominal rating of the heating capacity of the heat pump should set equal to the rated capacity of all heating equipment controlled by a setback thermostat in the home. The energy savings should be calculated per residence rather than per thermostat.

Coincidence Factor (CF)

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

Operating Hours

Nameplate capacity for heat pumps should include the full heating capacity of the heat pump system, including backup electric resistance heaters. Cooling and heating EFLH data by location, building type and vintage are tabulated in Appendix G.

Baseline Efficiencies from which Savings are Calculated

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

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

Compliance Efficiency from which Incentives are Calculated

The energy savings factor for heating ($F_{heating}$) is the ratio of the energy savings resulting from installation of a programmable setback thermostat to the annual heating energy. The heating energy savings factor assumption is taken from a study of programmable thermostat savings in Massachusetts conducted by RLW Analytics. The study estimated an energy savings of 6.8% of the annual heating energy consumption for programmable setback thermostats in residential applications.

The cooling energy savings factor ($F_{cooling}$) is the ratio of the energy savings resulting from installation of a programmable setback thermostat to the annual cooling energy. The cooling energy savings factor assumption is taken from the Energy Star website. The Energy Star calculator estimates an energy savings of 3% of the annual cooling energy consumption per degree of setback for programmable setback thermostats in residential applications. Assuming an average of 3 degrees of setback, the recommended value for the cooling energy savings factor is 9%.

Operating Hours

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

Effective Useful Life (EUL)

Years: 11
Source: DEER

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. For examples of studies on residential thermostat set point behavior, see the literature review conducted for the California Energy Commission project "Residential Thermostats: Comfort Controls in California Homes," CEC-500-03-026, available at http://comfortcontrols.lbl.gov/pdf/tstats-lit-review.pdf.
2. Baseline thermostat setback assumptions taken from: Conner, C.C. and Lucas, R.L. 1990. Thermostat Related Behavior and Internal Temperatures Based on Measured Data in Residences. PNL-7465, Pacific Northwest Laboratory. Richland, WA.

3. The RLW study on thermostat energy savings can be found at www.cee1.org/eval/db_pdf/933.pdf
4. Programmable thermostat savings for the cooling season taken from the Energy Star website: www.energystar.gov

5. Electric resistance systems generally require line voltage thermostats capable of controlling the rated current of the baseboard unit. Programmable line voltage thermostats are not common, but are available. Thermostats controlling heat pumps should have a heat pump recovery mode to minimize operation of electric resistance heaters during the temperature recovery period.

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0	10/15/2010

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THERMOSTAT – Wi-Fi (COMMUNICATING)

Measure Description

This section covers Wi-Fi communicating thermostats 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. The unit must contain an outdoor air temperature algorithm in the unit's control logic to operate the primary heating and cooling systems.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Unit savings are deemed based on a recent evaluation study from New England[1].

Annual Gas Energy Savings

Δtherms = Annual gas savings per thermostat unit of 63 therms.

Annual Electric Energy Savings (Cooling)

ΔkWh = Annual electric energy savings per thermostat unit of 104 kWh.

Peak Coincident Demand Savings

ΔkW = Annual peak demand savings per thermostat unit of 0.23 kW.

Baseline Efficiencies from which Savings are Calculated

The baseline efficiency is an HVAC system using natural gas or electricity to provide space heating with either a manual or a programmable thermostat.

Compliance Efficiency from which Incentives are Calculated

The higher energy efficiency level is an HVAC system that has a Wi-Fi thermostat installed.

Effective Useful Life (EUL)

Years: 11
Source: DEER

Record of Revision

Record of Revision Number	Issue Date
1-16-19	1/1/2016

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[1] Cadmus Group (September 2012) Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation for the Electric and Gas Program Administrators of Massachusetts