11.1 Lighting End Use

11.1.1 LED Case Lighting

Measure Description

This measure realizes energy savings by replacing linear fluorescent T12HO or T8 lamps with light emitting diode (LED) lighting in refrigerated display cases. Savings and assumptions are based on the number of LED lights installed, assuming that each light strip is 5-ft long.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{(watts_{base} - watts_{ee})}{1{,}000\ W/kW} \times n_{strips} \times WHF_e \times HOU$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{(watts_{base} - watts_{ee})}{1{,}000\ W/kW} \times n_{strips} \times WHF_d \times CF$$

Where:

ΔkWh/year = gross annual electric energy savings

ΔkW = gross coincident demand reductions

$watts_{base}$ = connected watts of each baseline lighting strip

$watts_{ee}$ = connected watts of each LED strip

N_{strips}[174] = number of baseline lighting strips replaced with LED strips, assuming each strip is 5ft

WHF_d = waste heat factor for demand to account for cooling savings from efficient lighting

WHF_e = waste heat factor for energy to account for cooling savings from efficient lighting

HOU = annual lighting hours of use

CF = peak coincidence factor

[174] While the Mid-Atlantic TRM methodology uses linear feet of LED case lighting installed to calculate savings, due to the nature of the data that is available for this measure, DNV GL adjusted the formulas to calculate savings based on the number of strips installed, assuming that each strip is 5 ft according to the Mid-Atlantic TRM default assumptions. The data for this measure was determined at the beginning of the program launch, when the deemed savings method was slightly different than the current method and linear feet was not deemed necessary to collect.

Input Variables

Table 50: Input Values for LED Case Lighting Savings Calculations

Component	Type	Value	Unit	Source(s)
$watts_{base}$	Variable	See customer application.	watts	Customer application
		Default = 76[175]		Mid-Atlantic TRM 2016, p. 377[176]
$watts_{ee}$	Variable	See customer application.	watts	Customer application
		Default = 38[177]		Mid-Atlantic TRM 2016, p. 377[178]
N_{strips}	Variable	See customer application.	doors	Customer application
		Default = 1		Per unit savings[179]
WHF_e	Variable	Low Temp (-35 to -1°F): 1.52 Med Temp (0 - 30°F): 1.52 High Temp (31 - 55°F): 1.41 Default value: 1.41	-	Mid-Atlantic TRM 2016, p. 377
WHF_d	Variable	Low Temp (-35 to -1°F): 1.51 Med Temp (0 - 30°F): 1.51 High Temp (31 - 55°F): 1.40 Default value: 1.40	-	Mid-Atlantic TRM 2016, p. 377-378
HOU	Fixed	See Table 135 for grocery building type.	hours /year	Mid-Atlantic TRM 2016, p. 504
CF	Fixed	See Table 135 for grocery building type.	-	Mid-Atlantic TRM 2016, p. 505[180]

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

175 Calculated as 15.2 W/ft x 5 ft = 76 W

176 wattsbase comes from the T8 baseline fixture option from the LED Refrigerated Case Lighting measure of the Mid-Atlantic TRM 2016.

177 Calculated as 7.6 W/ft x 5ft = 38 W

178 $watts_{ee}$ comes from LED Refrigerated Case Lighting measure of the Mid-Atlantic TRM 2016.

179 Five feet is the assumed lighting strip length. Use this value when only the number of installed strips is available.

180 CF value for "grocery" building type.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\begin{aligned}\Delta kWh/year &= \frac{(watts_{base} - watts_{ee})}{1{,}000W/kW} \times n_{strips} \times WHF_e \times HOU \\ &= \frac{(76\ watts - 38\ watts)}{1{,}000\ W/kW} \times 1\ strip \times 1.4 \times 7{,}134\ hours \\ &= 379.5\ kWh/year\end{aligned}$$

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\Delta kW = \frac{(watts_{base} - watts_{ee})}{1{,}000\ W/kW} \times n_{strips} \times WHF_d \times CF$$

$$= \frac{(76\ watts - 38\ watts)}{1{,}000\ W/kW} \times 1\ strips \times 1.4 \times 0.96$$

$$= 0.05\ kW$$

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2016, p. 377-378 and p. 505.

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11.1.2 LED Exit Sign

Measure Description

This measure realizes energy savings by installing an exit sign that is illuminated with light emitting diodes (LED). This measure should be limited to retrofit installations.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/\ year = \frac{((quantity\ \times\ watts)_{baseline} - (quantity\ \times\ watts)_{installed})}{1{,}000\ W/kW} \times HOU \times WHF_e\ \times ISR$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{((quantity\ \times\ watts)_{baseline} - (quantity\ \times\ watts)_{installed})}{1{,}000\ W/kW} \times WHF_d \times CF \times ISR$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
$quantity_{baseline}$ = number of existing exit signs
$quantity_{installed}$ = number of LED exit sign replacements. It is assumed that the $Quantity_{baseline}$ equals $Quantity_{installed}$
$watts_{baseline}$ = connected load of the existing exit sign, measured in watts
$watts_{installed}$ = connected load of the LED exit sign, measured in watts
HOU = average hours of use per year
WHFe = waste heat factor for energy to account for cooling savings from efficient lighting
WHFd = waste heat factor for demand to account for cooling savings from efficient lighting
CF = summer peak coincidence factor
ISR = in-service rate is the percentage of rebated measures actually installed

Input Variables

Table 51: Input Values for LED Exit Sign Calculations

Component	Type	Value	Unit	Source(s)
$quantity_{baseline}$	Variable	See customer application.	-	Customer application
$quantity_{installed}$	Variable	Equal to $Quantity_{baseline}$	-	Customer application
$watts_{base}$	Variable	See customer application. Default: 16W CFL	watts	ENERGY STAR®[181]
$watts_{ee}$	Variable	See customer application. Default: 5W LED	watts	ENERGY STAR®

[181] LED exit sign default values come from an ENERGY STAR® report: Save Energy, Money and Prevent Pollution with Light-Emitting Diode (LED) Exit Signs. http://www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf (accessed 9/15/2016).

Component	Type	Value	Unit	Source(s)
HOU	Fixed	8,760	hours/ year	Mid-Atlantic TRM 2016 p. 314
WHFe	Variable	See Table 135.	-	Mid-Atlantic TRM 2016 p. 314
WHFd	Variable	See Table 135.	-	Mid-Atlantic TRM 2016 p. 315
CF	Fixed	1	-	Mid-Atlantic TRM 2016 p. 315
ISR	Fixed	1.0	-	Mid-Atlantic TRM 2016 p. 314

Note that the coincidence factor (CF) is 1 for this measure since exit signs are on continuously on, including during the entirety of the peak period.

Default Savings

No default savings will be awarded for this measure if the proper values are not provided in the customer application.

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2016, p. 314-317.

11.1.3 LED Reflector Lamp & A-line LED

Measure Description

This measure realizes energy savings by installing reduced wattage lamp/ ballast systems that have higher lumens per watt than existing systems. The savings estimation method is applied to lighting retrofits that install T8, T5, LED, or CFL lamps/ ballasts.

The measure also covers delamping of existing lighting systems. Delamping includes removal of one or more lamps in a fixture (e.g. removing two lamps out of four lamp fixtures), or removal of the entire fixture itself, so that there is no longer a connected load. Similarly to lamp and fixture retrofit calculations, changes in load due to delamping are tracked through the difference between baseline and installed wattage.

Gross coincident demand reductions for delamping measures are included in PJM EE Resource nominations when reflectors or tombstones are installed such that the measure is defined as persistent.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{(Watts_{baseline} \times Quantity_{baseline} - Watts_{installed} \times Quantity_{installed}) \times HOU \times WHF_e \times ISR}{1{,}000\, W/kW}$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{(Watts_{baseline} \times Quantity_{baseline} - Watts_{installed} \times Quantity_{installed}) \times CF \times WHF_d \times ISR}{1{,}000\, W/kW}$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
$Quantity_{baseline}$ = quantity of existing or baseline fixtures/lamps
$Quantity_{installed}$ = quantity of installed fixtures/lamps
$Watts_{baseline}$ = load of the existing or baseline fixture/lamp on a per unit basis, measured in watts
$Watts_{installed}$ = load of installed fixture/lamps on a per unit basis, measured in watts
HOU = annual operating hours of the fixtures/lamps
WHFe = waste heat factor for energy to account for cooling savings from efficient lighting
WHFd = waste heat factor for demand to account for cooling savings from efficient lighting

CF = summer peak coincidence factor. The CF used for demand reductions will depend on the fixture that is delamped/removed as shown in in Table 32,

Table 133 and Table 135.

ISR = in-service rate is the percentage of rebated measures actually installed

Input Variables

Table 52: Input Values for Lighting Fixtures and Lamps

Component	Type	Value	Unit	Source(s)
$Quantity_{baseline}$	Variable	See customer application.	-	Customer application
		Default for new construction measures see Table 33.		Dominion non-residential lighting systems and controls participant data through year-end 2016
$Quantity_{installed}$	Variable	See customer application.	-	Customer application
$Watts_{baseline}$	Variable	See customer application.	watts	Customer application
		Default for new construction measures see Table 33.		Dominion non-residential lighting systems and controls participant data through year-end 2016
$Watts_{installed}$	Variable	See customer application.	watts	Customer application
CF	Fixed	See Table 133 and Table 135.	-	Mid-Atlantic 2016, p. 505[182]
HOU	Variable	See Table 133 and Table 136.	hours/ year	Mid-Atlantic 2016, p. 504
WHF_e	Variable	See Table 136.	-	Mid-Atlantic TRM 2016 p. 506-507[183]
WHF_d	Variable	See Table 136.	-	Mid-Atlantic TRM 2016 p. 506-507[184]
ISR	Fixed	1.00	-	Mid-Atlantic TRM 2016 p. 298

When developing STEP Manual 7.0.0 (year-end 2016), DNV GL used existing program data from Virginia and North Carolina Non-Residential Lighting Systems and Controls program participants to generate a list of ratios for each eligible measure type that is used as a multiplier to be

[182] The LED measures were grouped with other lighting applications' coincident factors based on their similar function or usage. LED downlights are assumed to be replacing CFL and T8 fixtures; LED or induction HE garage fixtures would be expected to replace PSMH in garage applications, and exterior LEDs replace exterior fixtures.

[183] Waste heat factor to account for cooling energy savings from efficient lighting. For a cooled space, the value is 1.13 (calculated as 1 + (0.74*(0.45) / 2.5)). Based on 0.45 ASHRAE Lighting waste heat cooling factor for Washington DC and estimate that 74% of commercial floorspace in the Mid-Atlantic region is cooled (Delmarva Commercial Baseline Research Project, Final Report, SAIC, 1995) with 2.5 C.O.P. typical cooling system efficiency (methodology adopted from ASHRAE Journal, Calculating Lighting and HVAC Interactions, 1993).

[184] Waste heat factor to account for cooling demand savings from efficient lighting. For a cooled space, the value is 1.25 (calculated as 1 + (0.74*(0.85) / 2.5)). Based on 2.5 COP cooling system efficiency, estimate that 74% of commercial floorspace in the Mid-Atlantic region is cooled (Delmarva Commercial Baseline Research Project, Final Report, SAIC, 1995), and 85% of lighting heat that needs to be mechanically cooled at time of summer peak (methodology adopted from ASHRAE Journal, Calculating Lighting and HVAC Interactions, 1993).

applied to the customer provided installed quantity times installed wattage to estimate a baseline default wattage times quantity for new construction measures where no baseline information is available. The default ratios were generated using the following variables from available lighting retrofit measure records for all program particiapnts through the end of 2016:

- installed wattage
- installed quantity
- baseline wattage
- baseline quantity

Table 53. Default Ratio for Calculating Baseline Lighting Wattage Multipled with Baseline Quantity

New Fixture	Base Fixture	Ratio
T8 - 2 - 2ft 17watt Lamps with Reflector & NB	2 Bi-ax Lamps in 2x2, 2U-bends	2.5
T8 - 3 - 2ft 17watt Lamps with Reflector & NB	2 Bi-ax Lamps in 2x2, 2U-bends	1.6
T8 Enclosed Fixture - 2 Lamp NB No Reflector 24/7	75W – 100W HID	2.4
T8 Enclosed Fixture - 3 Lamp NB No Reflector 24/7	150W – 175W HID	2.6
T8 Enclosed Fixture - 4 Lamp HB Miro Reflector	T8 – 4ft 4 Lamp	
T8 High-Bay - 4ft 3 lamp	150W – 175W HID	2.0
T8 High-Bay - 4ft 4 lamp	250W HID	2.2
T8 High-Bay - 4ft 6 lamp	400W HID	2.3
T8 High-Bay - 4ft 8 lamp	400W HID	1.6
T8 High-Bay - Double Fixture 4ft 6 lamp	1,000W HID	2.8
T8 High-Bay - Double Fixture 4ft 8 lamp	1,000W HID	1.8
LW HPT8 4ft 1 lamp	T8	2.6
LW HPT8 4ft 2 lamp	T8	3.1
LW HPT8 4ft 3 lamp	T8	3.4
LW HPT8 4ft 4 lamp	T8	1.4
HPT8 T8 4ft 2 lamp	T12HO – 8ft 1 Lamp	2.9
HPT8 T8 4ft 4 lamp	T12HO – 8ft 2 Lamp	5.8
T5 HO Enclosed - 1 lamp 24/7	75W – 100W HID	
T5 HO Enclosed - 2 lamp 24/7	150W – 175W HID	
T5 HO Enclosed - 3 lamp 24/7	250W HID	
2 Lamp T5 28W 24/7	75W – 150W HID	

New Fixture	Base Fixture	Ratio
T5 HO Enclosed - 2 lamp Miro Reflector 24/7	250W HID	
T5 2 - 2ft lamps 24 watts	75W – 100W HID	2.1
T5 3 - 2ft lamps 24 watts	150W HID	
T5 4 - 2ft lamps 24 watts	175W HID	
T5 3 - 4ft HO Lamps	250W HID	1.3
T5 HO - Highbay 2L	150W – 175W HID	2.2
T5 HO - Highbay 3L	250W HID	1.9
T5 HO - Highbay 4L	400W HID	2.1
T5 HO - Highbay 6L	400W HID	1.5
T5HO - Double fixture Highbay 5L	1,000W HID	
T5HO - Double Fixture Highbay 6L	1,000W HID	
CFL - Screw In (bulb only) - <30W	Incandescent (EISA Standard)	3.5
CFL - Screw In (bulb only) - 30W or greater	Incandescent (EISA Standard)	4.0
CFL - Fixture/Wallpack		5.3
CFL - Hardwired fixture	Incandescent (EISA Standard)	
LED Exit Signs	Standard Exit Sign	11.3
LED Downlight Fixture >=31W	2x4 T8 Fluorescent	4.3
LED Downlight 13-30W (excludes screw-in lamps)	Incandescent Downlight 76W – 150W (EISA Standard)	4.8
LED 2X4 FIXTURE (39-80W)	2x4 T8 Fluorescent	3.1
LED Fixture (2x2 or 1x4)	2 2x2 Bi-ax Lamps, 2U-bends, 2L 4ft T8	3.3
LED Lamps (<= 7W)	≤ 30W Equiv. (EISA Standard)	6.4
LED Lamps (>7W up to 12W) (excludes screw-in lamps)	31W – 75W Lamps (EISA Standard)	6.4
LED or Induction HE		5.7
LED or Induction HE Exterior		4.1
LED or Induction HE Garage		4.2
T8 to HPT8 Conver, reduce bulbs, add reflector		24.4
LED Exterior New Fixture		4.6
LED Interior New Fixture		3.5
LED 24/7		1.9
LED		3.4
LED Highbay		1.8

New Fixture	Base Fixture	Ratio
LED Panels		2.8
LED Panels on Belly Pan		2.2
LED Display Case Lighting		2.5
LED Screw In		5.8
LW HPT8 – 4ft 2 Lamp with Reflector and Delamp		2.3
LW HPT8 – 4ft 3 Lamp with Reflector and Delamp	T8 – 3 Lamp	2.6
LW HPT8 – 4ft 1 Lamp with Reflector and Delamp	T8 – 2 Lamp	2.6
LED – 4 linear 4ft Tube/Bar	T8 – 4ft 4 Lamp	2.1
LED – 3 linear 4ft Tube/Bar	T8 – 4ft 3 Lamp	2.0
LED – 2 linear 4ft Tube/Bar	T8 – 4ft 2 Lamp	2.0
LED – 1 linear 4ft Tube/Bar	LED – 1 Linear 4ft Tube/Bar T8 – 4ft 1 Lamp	2.3
LED – 1 linear 4ft Tube/Bar – 1 T8 Delamp	LED – 1 Linear 4ft Tube/Bar T8 – 4ft 1 Lamp	3.3
LED – 2 linear 4ft Tube/Bar – 1 T8 Delamp	T8 – 4ft 2 Lamp	2.4
LED – 3 linear 4ft Tube/Bar – 1 T8 Delamp	T8 – 4ft 3 Lamp	3.3
LED – 2 linear 4ft Tube/Bar – 2 T8 Delamp	T8 – 4ft 4 Lamp	3.2
LED Linear/Bar		1.9
Default		4.1

Default Savings

No default savings will be awarded for this measure if the proper values are not provided in the customer application.

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2016, p. 296 – 317 and p. 504 – 507.

11.1.4 Occupancy Sensor

Measure Description

This measure defines the savings associated with installing occupancy sensors or daylighting dimming control systems. Wall-, fixture, or remote-mounted occupancy sensors switch lights off after a brief delay when they do not detect occupancy.

This measure is offered in both the Non-Residential Lighting Systems and Controls program as well as the Non-Residential Small Business Improvement program, described in Section 15.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = Quantity_{sensors} \times \frac{Watts_{connected}}{1{,}000\, W/kW} \times HOU \times SVGe \times WHF_e \times ISR$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = Quantity_{sensors} \times \frac{Watts_{connected}}{1{,}000\, W/kW} \times SVGd \times CF \times WHF_d \times ISR$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
$Quantity_{sensors}$ = number of occupancy sensors to be installed
$Watts_{connected}$ = total connected load of the lighting controlled by the sensors
HOU = average hours of use per year
SVG_e = Percentage of annual lighting energy saved by lighting control
SVGd = Percentage of lighting demand saved by lighting control
WHFe = waste heat factor for energy to account for cooling savings from efficient lighting
WHFd = waste heat factor for demand to account for cooling savings from efficient lighting
CF = summer peak coincidence factor
ISR = in-service rate is the percentage of rebated measures actually installed

Input Variables

Table 54: Input Values, Lighting Sensors and Controls

Component	Type	Value	Unit	Source(s)
$Watts_{connected}$	Variable	See customer application.	watt	Customer application
HOU	Variable	See Table 136.	hours/year	Mid-Atlantic TRM 2016, p. 504
$Quantity_{sensors}$	Variable	See customer application.	-	Customer application
SVG_e	Fixed	Occupancy sensor and daylight dimming control = 0.28	-	Mid-Atlantic TRM 2016 p. 326-333
SVG_d	Fixed	Occupancy sensor = 0.14	-	Mid-Atlantic TRM 2016 p. 326-333
CF	Fixed	See Table 134 and Table 136.	-	Mid-Atlantic TRM 2016, p. 505
WHFe[185]	Variable	See Table 136.	-	Mid-Atlantic TRM 2016 p. 506-507
WHFd[186]	Variable	See Table 136.	-	Mid-Atlantic TRM 2016 p. 506-507
ISR	Fixed	1.00	-	Mid-Atlantic TRM 2016 p. 326-333

Default Savings

No default savings will be awarded for this measure if the proper values are not provided in the customer application.

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2016, p. 326-333.

[185] Waste heat factor to account for cooling energy savings from efficient lighting. For a cooled space, the value is 1.13 (calculated as 1 + (0.74*(0.45) / 2.5)). Based on 0.45 ASHRAE Lighting waste heat cooling factor for Washington DC and estimate that 74% of commercial floorspace in the Mid-Atlantic region is cooled (Delmarva Commercial Baseline Research Project, Final Report, SAIC, 1995) with 2.5 C.O.P. typical cooling system efficiency (methodology adopted from ASHRAE Journal, Calculating Lighting and HVAC Interactions, 1993).

[186] Waste heat factor to account for cooling demand savings from efficient lighting. For a cooled space, the value is 1.25 (calculated as 1 + (0.74*(0.85) / 2.5)). Based on 2.5 COP cooling system efficiency, estimate that 74% of commercial floorspace in the Mid-Atlantic region is cooled (Delmarva Commercial Baseline Research Project, Final Report, SAIC, 1995), and 85% of lighting heat that needs to be mechanically cooled at time of summer peak (methodology adopted from ASHRAE Journal, Calculating Lighting and HVAC Interactions, 1993).

11.1.5 Reach-In Unit Occupancy Sensor

Measure Description

This measure realizes energy savings by adding occupancy sensors to reach-in refrigerated display case lighting. Occupancy sensors reduce energy usage by turning off lights when customers are not present. Savings and assumptions are based on the lighting load controlled by each occupancy sensor.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{Watts}{1{,}000\ W/kW} \times OSS \times HOU$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{Watts}{1{,}000\ W/kW} \times OSS \times CF$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
Watts = connected lighting load controlled by occupancy sensor
OSS = occupancy sensor savings, resulting from a reduction in operating hours
HOU = annual lighting hours of use
CF = peak coincidence factor

Input Variables

Table 55: Input Values for Reach-In Unit Occupancy Sensors Savings Calculations

Component	Type	Value	Unit	Source(s)
Watts	Variable	See customer application.	watts	Customer application
		Default = 38		Same default as from LED Case lighting measure $Watts_{ee}$ for five foot lamp
OSS	Fixed	0.307	-	Maine Commercial TRM 2016, p. 33
HOU	Variable	See Table 136 for grocery building type.	hours/ year	Mid-Atlantic TRM 2016, p. 504[187]
CF	Fixed	See Table 136 for grocery building type.	-	Mid-Atlantic TRM 2016, p. 505[188]

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculations:

$$\Delta kWh/year = \frac{Watts}{1{,}000\ W/kW} \times OSS \times HOU$$

$$= \frac{38\ watts}{1{,}000\ W/kW} \times 0.307 \times 7{,}134\ hours/year$$

$$= 83\ kWh/year$$

The default gross coincident demand reductions will be assigned according to the following calculations:

$$\Delta kW = \frac{Watts}{1{,}000\ W/kW} \times OSS \times CF$$

$$= \frac{38\ watts}{1{,}000\ W/kW} \times 0.307 \times 0.96$$

$$= 0.011\ kW$$

187 No default HOU was provided in the Maine TRM 2016.2. It refers to data collected from the application. Since the STEP Manual does not use customer application HOU data, a default was assigned using annual hours from the Mid-Atlantic TRM 2016.

188 CFS_{SP} value for "grocery" building type.

Source(s)

The primary sources for this deemed savings approach are the Maine Commercial TRM 2016, p. 33 and Mid-Atlantic TRM 2016 p. 504-505.

11.2 Plug Load End Use

11.2.1 ENERGY STAR® Software

Measure Description

This measure realizes energy savings by installing computer software that commands a computer's monitor and/or central processing unit (CPU) to go into a low power "sleep mode" after a designated period of time. This is different from a screen saver, which generally does not save energy. Laptops are not eligible for this measure and it is assumed that each CPU controls one monitor.

Savings Estimation Approach

Gross annual electric energy savings are calculated using the ENERGY STAR® Low Carbon IT Savings calculator.

Gross annual electric energy savings are assigned per unit as follows:

$$\Delta kWh/year = 391.8\ kWh/year$$

Gross coincident demand reductions are assigned per unit as follows:

$$\Delta kW = 0\ kW$$ [189]

Where:

ΔkWh/year = gross annual electric energy savings

ΔkW = gross coincident demand reductions

[189] No demand reductions are assigned for this measure, as the ENERGY STAR® Low Carbon IT Savings Calculator does not provide this value.

Input Variables

Table 56: Input Values for ENERGY STAR® Software Savings Calculations

Component	Type	Value	Unit	Source(s)
Number of Desktop with PM Software	Variable	See customer application.	desktops	Customer application
		Default = 1		Per unit savings
Number of Monitors controlled by PM Software	Variable	See customer application.	monitors	Customer application
		Default = 1		Per unit savings
Percentage of Computers Turned Off During Non-Work Hours	Variable	See customer application.	-	Customer application
		Default = 0.36		ENERGY STAR®
Monitor Sleep Mode Settings	Variable	See customer application.	minutes	Customer application
		Default = 15		ENERGY STAR®
Computer Sleep Mode Settings	Variable	See customer application.	minutes	Customer application
		Default = 30		ENERGY STAR®
Office Hours	Variable	See customer application.	hours/ week	Customer application
		Default = 40		ENERGY STAR®
Number of Non-work Days	Fixed	See customer application.	days /year	Customer application
		Default = 22		ENERGY STAR®

The input values featured in Table 56 are direct inputs to the ENERGY STAR® Low Carbon IT Savings calculator.

Default Savings

Default savings are the same as described in the savings estimation approach.

Source(s)

The primary source for this deemed savings approach is the ENERGY STAR® Low Carbon IT.[190]

[190] http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon (accessed on August 11, 2016).

11.2.2 Plug Load Occupancy Sensor

Measure Description

This measure realizes energy savings by installing devices that control low wattage office equipment using an occupancy sensor. Such devices typically use an infrared sensor to monitor movement, and use a smart strip to turn off connected devices, or put them in standby mode, when no one is present.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{days_{work} \times \Delta Wh_{sleep}}{1{,}000\ W/kW}$$

Gross coincident demand reductions are assigned as follows:

$$\Delta kW = 0\ kW$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
$days_{work}$ = average number of workdays in a year
ΔWh_{sleep} = gross energy savings of device plugged into the strip when in "sleep" mode per day

Input Variables

Table 57: Input Values for Plug Load Occupancy Sensor Savings Calculations

Component	Type	Value	Unit	Source(s)
$Days_{work}$	Variable	See customer application.	days/year	Customer application
		Default = 240		Ohio TRM 2010, p. 282[191]
ΔWh_{sleep}[192]	Fixed	704	W-hours/ day	Ohio TRM 2010, p. 282

[191] Ohio TRM 2010, p. 282. Assumes two weeks of vacation and two weeks of holidays for a total of 48 work weeks annually.

[192] Ohio TRM 2010, p. 282. Based on table "Standby Power Consumption of Devices Using Smart Strip Plug Outlets."

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{days_{work} \times \Delta Wh_{sleep}}{1{,}000\ Wh/kW}$$

$$= \frac{240\ days/year \times 704\ Wh/day}{1{,}000\ W/kW}$$

$$= 169\ kWh/year$$

The default gross coincident demand reductions will be assigned as follows:

$\Delta kW = 0$ kW[193]

Source(s)

The primary source for this deemed savings approach is the Ohio TRM 2010, p. 282 – 283.

[193] No demand reductions are assigned for this measure in the Ohio TRM 2010.

11.2.3 Smart Strip

Measure Description

This measure realizes energy savings by installing a "smart-strip" plug outlet in place of a standard "power strip." A smart strip has the ability to minimize energy losses caused by phantom loads when the devices plugged into the smart strip are not in use.

The baseline condition is a standard "power strip". This strip is simply a "plug multiplier" that allows the user to plug in multiple devices using a single wall outlet. Additionally, the baseline unit has no ability to control power flow to the connected devices.

Savings Estimation Approach

Gross annual electric energy savings are assigned per unit as follows:

$$\Delta kWh/year = 26.9\ kWh/year$$ [194]

Gross coincident demand reductions are assigned as follows:

$$\Delta kW = 0\ kW$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 201, p. 4-467.

[194] Energy & Resource Solutions (ERS), 2013. "Emerging Technologies Research Report; Advanced Power Strips for Office Environments prepared for the Regional Evaluation, Measurement, and Verification Forum facilitated by the Northeast Energy Efficiency Partnerships." Assumes savings consistent with the 20W threshold setting for the field research site demonstrating higher energy savings (of two available sites). ERS noted that the 20 W threshold may be unreliable due to possible inaccuracy of the threshold setting in currently available units. It is assumed that future technology improvements will reduce the significance of this issue. Further, savings from the site with higher average savings was adopted (26.9 kWh versus 4.7 kWh) acknowledging that investigations of APS savings in other jurisdictions have found significantly higher savings. For example, Northwest Power and Conservation Council, Regional Technical Forum. 2011. "Smart Power Strip Energy Savings Evaluation" found average savings of 145 kWh.

11.3 Refrigeration End Use

11.3.1 Anti-Sweat Heat Control, Door Heater Control (Cooler and Freezer)

Measure Description

Anti-sweat door heaters (ASDH) prevent condensation from forming on cooler and freezer doors. By installing a control device to turn off door heaters when there is little or no risk of condensation, significant energy savings can be realized. There are two commercially available control strategies – (1) ON/OFF controls and (2) micropulse controls – that respond to a call for heating, which is typically determined using either a door moisture sensor or an indoor air temperature and humidity sensor to calculate the dew point. In the first strategy, the ON/OFF controls turn the heaters on and off for minutes at a time, resulting in a reduction in run time. In the second strategy, the micropulse controls pulse the door heaters for fractions of a second, in response to the call for heating.

Both of these strategies result in energy and demand savings. Additional savings come from refrigeration interactive effects. When the heaters run less, they introduce less heat into the refrigerated spaces and reduce the cooling load.

In the context of this program, it is assumed by DNV GL that all controls are ON/OFF controls, for the purposes of calculating annual electric savings and coincident demand reductions, because no data is provided on the type of controller that is installed.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\frac{\Delta kWh}{year} = kW_{base} \times (DC_{none} - DC_{control}) \times n \times HOU \times WHFe$$

Gross coincident demand reductions are assigned as follows:

$$\Delta kW = kW_{base} \times (DC_{none} - DC_{control}) \times WHFd \times CF$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
DC_{none} = Duty cycle (effective run time) of uncontrolled ASDH
$DC_{control}$ = Duty cycle (effective run time) of ASDH with controls
n = number of reach-in refrigerator or freezer doors controlled by sensor
HOU = annual operating hours
WHFe = Waste Heat Factor for Energy; represents the increased savings due to reduced waste heat from motors that must be rejected by the refrigeration equipment.
WHFd = Waste Heat Factor for Demand; represents the increased savings due to reduced waste heat from motors that must be rejected by the refrigeration equipment.
CF = Summer Peak Coincidence Factor

Input Variables

Table 58: Input Values for Freezer and Cooler Anti-Sweat Heater Controls and Door Heater Controls Savings Calculations

Component	Type	Value	Unit	Source(s)
kW_{base}	Variable	See customer application.	kW	Customer application
		0.13		Mid-Atlantic TRM 2016, p. 446[195]
n	Variable	See customer application.	-	Customer application
		Default = 1		Per-unit savings
DC_{none}	Fixed	0.907	-	Mid-Atlantic TRM 2016, p. 446
$DC_{control}$	Fixed	On/Off controls: 0.589	-	Mid-Atlantic TRM 2016, p. 446
HOU	Fixed	8,760	Hours/ year	Mid-Atlantic TRM 2016, p. 446
WHFe	Fixed	Low Temp (-35°F - -1°F): 1.50 Med Temp (0°F - 30°F): 1.50 High Temp (31°F - 55°F): 1.25	-	Mid-Atlantic TRM 2016, p. 446
WHFd	Fixed	Low Temp (-35°F - -1°F): 1.50 Med Temp (0°F - 30°F): 1.50 High Temp (31°F - 55°F): 1.25	-	Mid-Atlantic TRM 2016, p. 446
CF[196]	Fixed	On/Off controls: 0.32	-	Mid-Atlantic TRM 2016, p. 446

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\frac{\Delta kWh}{year} = kW_{base} \times (DC_{none} - DC_{control}) \times n \times HOU \times WHFe$$
$$= 0.13\, kW \times (0.907 - 0.589) \times 1\, unit \times 8{,}760 \frac{hours}{year} \times 1.25$$
$$= 453\, kWh/year$$

[195] Mid-Atlantic TRM 2016, p. 446. Original source Cadmus, 2015. "Commercial Refrigeration Loadshape Project." Lexington, MA.

[196] Mid-Atlantic TRM 2016, p. 446. Coincidence factors developed by dividing the PJM summer peak savings for ASDH controls from Table 52 by the product of the average Wattage of ASDH per connected door (0.13 kW) and the waste heat factor for demand.

The default gross coincident demand reductions will be assigned as follows:

$$\begin{aligned} \Delta kW &= kW_{base} \times WHFd \times CF \\ &= 0.13\,kW \times 1.25 \times 0.32 \\ &= 0.052\,kW \end{aligned}$$

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2016, p. 445 - 447.

11.3.2 Door Closer (Cooler and Freezer)

Measure Description

This measure realizes energy savings by installing an auto-closer on main doors to walk-in coolers or freezers, or by installing an automatic, hydraulic-type door closer on glass-reach-in doors to coolers or freezers. This measure consists of installing a door closer where none existed before. Gross annual electric energy savings are gained when an auto-closer installation reduces the infiltration of warmer outside air into a cooler or freezer environment.

Savings assume that an auto closer reduces warm air infiltration on average by 40% and the walk-in coolers and freezer doors have effective strip curtains.[197] To simulate the reduction, the main door open time is reduced by 40%. For walk-in coolers and freezers, savings are calculated with the assumption that strip curtains that are 100% effective are installed on the doorway.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Small Business Improvement program, described in Section 15, and the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are assigned according to the refrigeration unit type and temperature setting:

Cooler Doors

$$\Delta kWh/year = \Delta kWh/year_{cooler}$$

Freezer Doors

$$\Delta kWh/year = \Delta kWh/year_{freezer}$$

Gross coincident demand reductions are assigned according to the refrigeration unit type and temperature setting:

Cooler Doors

$$\Delta kW = \Delta kW_{cooler}$$

Freezer Doors

$$\Delta kW = \Delta kW_{freezer}$$

Where:

[197] Tennessee Valley Authority TRM 2017, p. 126. Original sources: California Database for Energy Efficiency Resources, www.deeresources.com (DEER 2008), and San Diego Gas & Electric work paper WPSDGENRRN0110 Rev 0, August, 17, 2012, "Auto-Closers for Main Cooler of Freezer Doors"

$\Delta kWh/year$ = gross annual electric energy savings
ΔkW = gross coincident demand reductions
$\Delta kWh/year_{cooler}$ = annual kWh savings for main cooler doors
ΔkW_{cooler} = summer peak kW savings for main cooler doors
$\Delta kWh_{freezer}$ = annual kWh savings for main freezer doors
$\Delta kWfreezer$ = summer peak kW savings for main freezer doors

Input Variables

Table 59: Door Closer Gross Annual Electric Energy and Gross Coincident Demand Reductions (per closer)[198]

Refrigeration Unit Type	Location	Walk-In		Reach-In	
		ΔkWh/ year	ΔkW	ΔkWh/ year	ΔkW
Cooler (High Temperature, 31°F to 55°F)	Richmond, VA	44	0.0050	102	0.0116
	Charlotte, NC	44	0.0050	101	0.0116
Freezer (Medium Temperature, -35°F to 30°F)	Richmond, VA	173	0.0196	439	0.0501
	Charlotte, NC	171	0.0195	435	0.0497

Default Savings

- If the proper values are not supplied, a default savings may be applied according to Table 59 and using conservative input values.

The default gross annual electric energy savings assume a high temperature walk-in cooler door:

$$\Delta kWh/year = 44\ kWh/year$$

The default gross coincident demand reductions assume a high temperature walk-in cooler door:

$$\Delta kW = 0.0050\ kW$$

Source(s)

The primary source for this deemed savings approach is the Tennessee Valley Authority TRM 2017, p. 199-200.

198 Methodology from Tennessee Valley Authority TRM 2017, p. 125-127 was used. Savings were revised using the TMY3 weather data for Richmond, VA and Charlotte, NC.

11.3.3 Refrigeration Coil Cleaning

Measure Description

This measure realizes energy savings by cleaning the condenser coils on reach-in and walk-in refrigerators and freezers. Eligible units will have 25% fouling or greater based on visual inspection. This measure may only receive energy savings and demand reduction when combined with the floating head pressure measure.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = load \times \frac{3.516\ kW/ton}{COP} \times HOU \times SF_e$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = load \times 3.156\ kW/ton \times COP \times SF_d$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
load = total capacity of condensers
COP = coefficient of performance of refrigeration unit
HOU = annual hours of use
SF_e = savings factor attributable to coil cleaning for electric energy savings
SF_d = savings factor attributable to coil cleaning for peak demand reductions

Input Variables

Table 60: Input Values for Refrigeration Coil Cleaning Savings Calculations

Component	Type	Value	Unit	Source(s)
load	Variable	See customer application.	tons	Customer application
COP	Fixed	Low Temp (-35°F - -1°F): 1.3 Med Temp (0°F - 30°F): 1.3 High Temp (31°F - 55°F): 2.5	-	Pennsylvania TRM 2016.1, p. 391
HOU	Fixed	Low Temp (-35°F - -1°F): 6,370 Med Temp (0°F - 30°F): 6,370 High Temp (31°F - 55°F): 6,1735	hours/ year	Calculated duty cycle using weather factor, defrost

Component	Type	Value	Unit	Source(s)
				factor, and capacity factor[199]
SF_e[200]	Fixed	0.048	-	Qureshi and Zubair (2011)
SF_d[201]	Fixed	0.022	-	Qureshi and Zubair (2011)

Default Savings

If the proper values are not supplied, no default savings will be awarded for this measure.

Source(s)

The primary sources for this deemed savings approach are the Pennsylvania TRM 2016 and "Performance degradation of a vapor compression refrigeration system under fouled conditions" by Qureshi and Zubair (2011), published in the *International Journal of Refrigeration*.

[199] The duty cycle is calculated using the same method as TVA 2016 TRM for refrigeration measures. For coolers, a defrost factor of 0.995, capacity factor of 0.87 and weather factor of 0.84 is assumed. For freezers, a defrost factor of 0.90, capacity factor of 0.87 and weather factor of 0.90 is assumed.

[200] Qureshi B.A. and Zubair S.M., "Performance degradation of a vapor compression refrigeration system under fouled conditioned." International Journal of Refrigeration 24 (2011), p. 1016 – 1027. Figure 2-(a). Assumes a weighting of refrigerant types of 80% R-134 and 20% R-404.

[201] Ibid.

11.3.4 Door Gasket (Cooler and Freezer)

Measure Description

This measure realizes energy savings by replacing worn-out gaskets with new gaskets on refrigerator or freezer doors to reduce heat loss caused by air infiltration.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Small Business Improvement program, described in Section 15, and the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach[202]

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \Delta kWh/ft \times L$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \Delta kW/ft \times L$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
ΔkWh/year·ft = gross annual electric energy savings per linear foot
ΔkW/ft = gross coincident demand reductions per linear foot
L = length of gasket applied in linear feet

Input Variables

Table 61: Input Values for Door Gasket Savings Calculations

Component	Type	Value	Unit	Source(s)
ΔkWh/year·ft	Variable	See Table 62	kWh/feet	Tennessee Valley Authority TRM 2016, p. 194.
ΔkW/ft	Variable	See Table 62	kW/feet	Tennessee Valley Authority TRM 2016, p. 194.
L	Variable	See customer application.	feet	Customer application
		Default = 15		DNV GL judgment

[202] Electric energy and demand savings for this measure are based on modeled results found in the Tennessee Valley Authority TRM 2017, which based its model assumptions and equations on 3 sources: the California Database for Energy Efficiency Resources, www.deeresources.com (DEER 2008), the 2009 Southern California Edison Company - WPSCNRRN0004.1 - Door Gaskets for Glass Doors of Walk-In Coolers work paper, and the 2009 Southern California Edison Company- WPSCNRRN0001.1 - Door Gaskets for Main Door of Walk-in Coolers and Freezers work paper.

Table 62: Door Gasket Gross Annual Electric Energy and Gross Coincident Demand Reductions (per linear foot) [203]

Refrigeration Type	ΔkWh/ year ·ft	ΔkW/ft
Freezer (-35°F to 30°F)		
Walk-In Door	29.5	0.0036
Reach-In Glass Door	22.2	0.0025
Cooler (31°F to 55°F)		
Walk-In Door	9.3	0.0011
Reach-In Glass Door	3.4	0.0004

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings per unit cooler/freezer will be assigned according to the following calculation:

$$\Delta kWh/year = \Delta kWh/ft \times L$$

$$= 3.4\, kWh/ft \times 15\, ft$$

$$= 51.0\, kWh/year$$

The default gross demand energy savings per unit cooler/freezer will be assigned according to the following calculation:

$$\Delta kW = \Delta kW/ft \times L$$

$$= 0.0004\, kW/ft \times 15\, ft$$

$$= 0.006\, kW$$

Source(s)

The primary source for this deemed savings approach is the Tennessee Valley Authority TRM 2016, p. 193 - 195.

[203] Tennessee Valley Authority 2017, p. 122. Methodology was used. Weather data was applied for Richmond, VA and Charlotte, NC. The difference between these locations was less than 1%, so Richmond values are applied to both VA and NC installed measures.

11.3.5 Evaporator Fan Electronically Commutated Motor (ECM) Retrofit (Display Case and Walk-in)

Measure Description

Evaporator fans circulate air in refrigerated spaces by drawing air across the evaporator coil and into the space. Fans are found in both reach-in and walk-in coolers and freezers. Energy and demand savings for this measure are achieved by reducing motor operating power. Additional savings come from refrigeration interactive effects. Because electronically-commutated motors (ECMs) are more efficient and use less power, they introduce less heat into the refrigerated space compared to the baseline motors and result in a reduction in cooling load on the refrigeration system.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = n \times \frac{(W_{base} - W_{ee})}{1{,}000\ W/kW} \times CW_{rated} \times DC_{evap} \times HOU \times WHFe$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW_{peak} = n \times \frac{(W_{base} - W_{ee})}{1{,}000\ W/kW} \times CW_{rated} \times \mathrm{WHFd} \times CF$$

If the application shows that the rated wattage of existing/baseline evaporator fan motor, W_{base}, is less than rated wattage of electronically commutated evaporator fan motor, W_{ee}, then it assumed that the baseline motor was replaced with a larger energy efficient motor. In such instances, the default values for these variables—provided in Table 63—are to be used.

Where:

$\Delta kWh/year$ = gross annual electric energy savings, kWh/year
ΔkW_{peak} = gross coincident demand reductions, kW
n = number of motors replaced, dimensionless
W_{base} = rated wattage of existing/baseline evaporator fan motor, W
W_{ee} = rated wattage of electronically commutated evaporator fan motor, W
CW_{rated} = conversion factor of rated wattage to connected load wattage, dimensionless
DC_{evap} = duty cycle (effective run time) of uncontrolled evaporator fan motors, dimensionless
HOU = annual operating hours, hr/year
WHFe = Waste Heat Factor for Energy; represents the increased savings due to reduced waste heat from motors that must be rejected by the refrigeration equipment, dimensionless
WHFd = Waste Heat Factor for Demand; represents the increased savings due to reduced waste heat from motors that must be rejected by the refrigeration equipment, dimensionless

CF = Summer Peak Coincidence Factor, dimensionless

Input Variables

Table 63: Input Values for ECM Evaporator Savings Calculations

Component	Type	Value	Unit	Source(s)
n	Variable	See customer application.	motors	Customer application
		Default = 1		Per unit savings
W_{base}	Variable	See customer application.	watts	Customer application
		Default: Walk-in: 128 Reach-in: 31 (default if refrigeration system type is unknown)		Mid-Atlantic TRM 2016, p. 449[204]
W_{ee}	Variable	See customer application.	watts	Customer application
		Default: Walk-in: 50, Reach-in: 12 (default if refrigeration system type is unknown)		Commercial Refrigeration Loadshape Project 2015, NEEP, p. 5[205]
CW_{rated}	Fixed	1.02	-	Commercial Refrigeration Loadshape Project NEEP 2015, p. 6[206]
DC_{evap}	Fixed	0.978		Mid-Atlantic TRM 2016, p. 449
HOU	Variable	8,760	hours/ year	Mid-Atlantic TRM 2016, p. 449
WHFe	Fixed	Low Temp (-35°F - -1°F): 1.76 Med Temp (0°F - 30°F): 1.76 High Temp (31°F - 55°F): 1.38	-	Mid-Atlantic TRM 2016, p. 449
WHFd	Fixed	Low Temp (-35°F - -1°F): 1.76 Med Temp (0°F - 30°F): 1.76 High Temp (31°F - 55°F): 1.38	-	Mid-Atlantic TRM 2016, p. 449
CF	Fixed	1.53[207]	-	Mid-Atlantic TRM 2016, p. 449

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

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[204] The Mid-Atlantic TRM approach states the default power reduction is 157%, The W_{base} are based on the default W_{ee} values and a 157% power reduction.

[205] The Commercial Refrigeration Loadshape Project, NEEP 2015, p. 5, finds that the average new ECM motor is rated at 1/15 hp. This study had the majority of motors installed in walk-in cases. Therefore, 1/50 hp or 50 W is

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \mathrm{n} \times \frac{(W_{base} - W_{ee})}{1{,}000\ W/kW} \times\ CW_{rated}\ \times DC_{evap} \times HOU \times WHFe$$
$$= 1\ \mathrm{unit}\ \times \frac{(31\mathrm{W} - 12\mathrm{W})}{1{,}000 \frac{\mathrm{W}}{\mathrm{kW}}} \times 1.02 \times 0.978 \times 8{,}760 \frac{\mathrm{hours}}{\mathrm{year}} \times 1.38$$

$$= 229\ kWh/year$$

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\Delta kW_{peak} = n \times \frac{(W_{base} - W_{ee})}{1{,}000\ W/kW} \times\ CW_{rated}\ \ \times WHFd \times CF$$

$$\Delta kW_{peak} = 1\ \mathrm{unit}\ \times \frac{(31\mathrm{W} - 12\mathrm{W})}{1{,}000\ \mathrm{W/kW}} \times 1.02 \times\ 1.38 \times 1.53$$

$$= 0.041\ \mathrm{kW}$$

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2017, p. 410 – 412.

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the default for walk-in applications. Default size for reach-in cases is the smallest motor sizes identified in this study; 1/62 hp or 12 watts.

[206] The Commercial Refrigeration Loadshape Project, NEEP 2015, p. 6, provides normalized ECM motor watts by rated horsepower based on measurement data from 66 sites. The values collected on application are in rated wattage instead of rated horsepower. Therefore, the 758W/hp is converted to 1.02 connected watts/ rated watts (758 W/hp divided by 746 W/hp).

[207] Mid-Atlantic TRM 2017, p. 411. Coincidence factors developed by dividing the PJM Peak Savings for EF Motors and Controls from Table 47 by the product of the average ECM wattage per rated horsepower (0.758 kW/hp) and the Waste Heat Factor for Demand. Note: the CF is greater than one because it is calculated relative to the wattage of the post-retrofit ECM motor as opposed to the existing SP motor.

11.3.6 Evaporator Fan Control (Cooler and Freezer)

Measure Description

This measure realizes energy savings by installing evaporator controls for reach-in or walk-in coolers and freezers. Typically, evaporator fans run constantly (24 hours per day, 365 days per year) to provide cooling when the compressor is running, and to provide air circulation when the compressor is not running. This measure saves energy by cycling the fan on and off when the compressor is not running to reduce fan usage by reducing the refrigeration load resulting from the heat given off by the fan.

This measure only applies to evaporator fans operating without existing controls. This approach applies to reach-in or walk-in freezers and refrigerator units, and is not applicable to refrigerated warehouses or other industrial refrigeration applications.[208] This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \Delta kW \times 8{,}760\ hours/year$$

Gross coincident demand reductions are calculated according to the following equation[209]:

$$\Delta kW = (kW_{evap} \times DC_{evap}) \times (1 - DC_{comp}) \times DC_{evap} \times BF$$

Where:

ΔkWh/year = gross annual electric energy savings, kWh/year
ΔkW = gross coincident demand reductions, kW
kW_{evap} = connected load of evaporator fans attached to control, kW
DC_{comp} = duty cycle (DC) of the compressor, dimensionless
DC_{evap} = DC of the evaporator fan, dimensionless
BF = bonus factor for reduced cooling load from replacing the evaporator fan with a lower wattage circulating fan when the compressor is not running, dimensionless

[208] This approach does not apply to industrial refrigeration warehouse type applications, where circulating fans may be applicable.

[209] Texas Non-Residential TRM 2016 - revised, p. 2-154. The equation in the Texas TRM includes the load from a circulation fan, which is assumed to be part of the control system. No circulation fans will be installed as part of this measure; therefore, the circulation fan load has been excluded from this equation.

Input Variables

Table 64: Input Values for Freezer and Cooler Evaporator Fan Controls Saving Calculations

Component	Type	Value	Unit	Source(s)
kW_{evap}	Variable	See customer application.	kW	Customer application
		Default = 0.123		Texas Non-Res TRM 2016 - revised, p. 2-155[210]
n_{fans}	Variable	See customer application.	-	Customer application
		Default = 1		Per unit savings
DC_{comp}[211]	Fixed	0.50	-	Texas Non-Residential TRM 2016 – revised, p. 2-155
DC_{evap}	Fixed	Cooler: 1.00 Freezer: 0.94[212]	-	Texas Non-Residential TRM 2016 - revised, p. 2-155
BF[213]	Variable	Low Temp[214] (-35°F - -1°F): 1.77 Med Temp (0°F - 30°F): 1.77 High Temp (31°F - 55°F): 1.40	-	Texas Non-Residential TRM 2016 - revised, p. 2-155 and Pennsylvania TRM 2016, p. 391

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\begin{aligned}\Delta kWh/year &= \Delta kW \times 8{,}760\ hours/year \\ &= 0.086\ kW \times 8{,}760\ hours/year \\ &= 753\ kWh/year\end{aligned}$$

The default gross coincident demand reductions will be assigned according to the following calculation:

210 Texas Non-Residential TRM 2016 - revised, p. 2-151 to 2-156. Based on a weighted average of 80% shaded pole motors at 132 watts and 20% PSC motors at 88 watts. This weighted average is based on discussions with refrigeration contractors and is considered conservative (market penetration estimated at approximately 10%).

211 Texas Non-Residential TRM 2016 - revised, p. 2-155. A 50% duty cycle is assumed based on examination of duty cycle assumptions from Richard Traverse (35%-65%), Cooltrol (35%-65%), Natural Cool (70%), Pacific Gas & Electric (58%). Also, manufacturers typically size equipment with a built-in 67% duty factor and contractors typically add another 25% safety factor, which results in a 50% overall duty factor.

212 Texas Non-Residential TRM 2016 - revised, p. 155. An evaporator fan in a cooler runs all the time, but a freezer only runs 8,273 hours per year due to defrost cycles (four 20-min defrost cycles per day).

213 The Texas Non-Res TRM 2016 - revised, p. 155 Bonus factor (1+ 1/COP) equation was used, however, the COP is from the PA TRM 2016, to reflect more appropriate COP values. Low and medium temp BF = 1+1/1.3 = 1.77. High temp BF = 1+1/2.5 = 1.4.

$$\Delta kW = \left(\left(kW_{evap} \times n_{fans}\right)\right) \times \left(1 - DC_{comp}\right) \times DC_{evap} \times BF$$

$$= \left((0.123\ kW \times 1)\right) \times (1 - 0.5) \times 1.00 \times 1.40$$

$$= 0.086\ \ kW$$

Source(s)

The primary source for this deemed savings approach is the Texas Non-Residential TRM 2016 - revised, p. 2-151 to 2-156.

11.3.7 Floating Head Pressure Control

Measure Description

This measure realizes energy savings by controlling condenser fans in the refrigeration system to change condensing temperatures in response to different outdoor temperatures. This is accomplished by the condensing fan controller through fan staging (*e.g.*, turning certain fans ON or OFF as necessary based on the condenser head pressure) or through varying the fan speed. As the outdoor temperature drops, the compressor will not have to work as hard to reject heat from the cooler or freezer.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = kWh_{HP} \times HP_{\mathrm{comp.}}$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kWh}{FLH}$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
kWh_{HP} = Floating head pressure control gross annual electric energy savings (kWh) per compressor horsepower (HP)
$HP_{comp.}$ = compressor HP

FLH = annual full load hours

Input Variables

Table 65: Input Values for Floating Head Pressure Control Savings Calculations

Component	Type	Value	Unit	Source(s)
kWh_{HP}	Variable	See Table 66. Default = 509 (High Temperature, Scroll Compressor)	kWh/horsepower/year	Efficiency Maine Commercial TRM 2016, p. 66-67
$HP_{comp.}$	Variable	See customer application.	horsepower	Customer application
		Default = 5		Vermont TRM 2015, p. 132[215]
FLH	Fixed	7,221	hours/year	Efficiency Maine Commercial TRM 2016, p. 66-67

Table 66: Floating Head Pressure Control Gross Annual Electric Energy Savings (per Horsepower)[216]

Compressor Type	Electric Savings (kWh/hp/year)		
	Low Temperature (-35°F to -1°F) (Ref. Temp. -20°F SST)	Medium Temperature (0°F to 30°F) (Ref. Temp. 20°F SST)	High Temperature (31°F to 55°F) (Ref. Temp. 45°F SST)
Standard Reciprocating	695	727	657
Discus	607	598	694
Scroll	669	599	509

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = kWh/year_{HP} \times HP_{\mathrm{comp.}}$$

$$= 509\, kWh/HP/year \times 5\, HP$$

$$= 2{,}545\, kWh/year$$

[215] Vermont TRM 2015, p. 132. Assumes "5 HP compressor data used, based on average compressor size."

[216] Efficiency Maine Commercial TRM 2016, Table 10 – Floating Head Perssure Control kWh Savings per Horsepower, p. 67.

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\begin{aligned}\Delta kW &= \frac{\Delta kWh/year}{FLH} \\ &= \frac{2{,}545\ kWh/year}{7{,}221\ hours/year} \\ &= 0.35\ kW\end{aligned}$$

Source(s)

The primary source for this deemed savings approach is the Efficiency Maine Commercial TRM 2016, p. 66-67.

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11.3.8 Refrigeration Night Cover

Measure Description

This measure realizes energy savings by installing a cover to minimize the energy losses associated with top open-case refrigeration units. Walk-in units are not included in this measure. The cover is used during hours which the business is closed. The baseline equipment is a refrigerated case without a night cover.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Small Business Improvement program, described in Section 15, and the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{load}{12{,}000\ Btu/hour/ton} \times \frac{3.516\ kW/ton}{COP} \times L \times ESF \times HOU$$

Gross coincident demand reductions are assigned as follows:

$$\Delta kW^{217} = 0$$

Where:

ΔkWh/year = gross annual electric energy savings
load = average refrigeration load in Btu/hr per linear foot of refrigerated case without night covers deployed, Btu/ft/hr
L = linear feet of covered refrigerated case, ft
COP = coefficient of performance of refrigerated case, dimensionless
ESF = energy savings factor; reflects the percentage reduction in refrigeration load due to the deployment of night covers, dimensionless
HOU = annual hours of use, hr/year

[217] Mid-Atlantic TRM 2017, p. 405.. Assumed that continuous covers are deployed at night; therefore, no demand savings occur during the peak period.

Input Variables

Table 67: Input Values for Refrigeration Night Cover Savings Calculations

Component	Type	Value	Unit	Source(s)
load	Fixed	See customer application.	Btu/hour/feet	Customer application
		Default = 1,500		Mid-Atlantic TRM 2016, p. 443[218]
L	Variable	See customer application.	feet	Customer application
		Default = 6		DNV GL Judgment
COP[219]	Fixed	2.2	-	Mid-Atlantic TRM 2016, p. 443
ESF[220]	Fixed	0.09	-	Mid-Atlantic TRM 2016, p. 444
HOU	Variable	Default = 8,760	hours/ year	Mid-Atlantic TRM 2016, p. 444

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{load}{12{,}000\ Btu/hour/ton} \times L \times \frac{3.156\ kW/ton}{COP} \times ESF \times HOU$$

$$= \frac{1{,}500\ Btu/hour/feet}{12{,}000\ Btu/hour/ton} \times \frac{3.516\ kW/ton}{2.2} \times 6\ feet \times 0.09 \times 8{,}760\ hours/year$$

$$= 9{,}45\ kWh/year$$

The default gross coincident demand reductions will be assigned as follows:

$$\Delta kW = 0$$

[218] Mid-Atlantic 2017, p. 404. Original source: Davis Energy Group, Analysis of Standard Options for Open Case Refrigerators and Freezers, May 11, 2004. (accessed on 7/7/2010.). http://www.energy.ca.gov/appliances/2003rulemaking/documents/case_studies/CASE_Open_Case_Refrig.pdf.

[219] Kuiken et al, Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0, KEMA, March 22, 2010.

[220] Mid-Atlantic TRM 2017, p. 405. Original source: Effects of the Low Emissivity Shields on Performance and Power Use of a Refrigerated Display Case, Southern California Edison, August 8, 1997. (accessed on July 7, 2010). http://www.sce.com/NR/rdonlyres/2AAEFF0B-4CE5-49A5-8E2C-3CE23B81F266/0/AluminumShield_Report.pdf. Characterization assumes covers are deployed for six hours per day.

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2016, p. 443 - 444.

11.3.9 Strip Curtain (Cooler and Freezer)

Measure Description

The measure realizes energy savings by installing strip curtains on walk-in coolers and freezers. Strip curtains reduce the refrigeration load by minimizing infiltration of non-refrigerated air into the refrigerated space of walk-in coolers or freezers. Strip curtains are assumed to be operational only during building operating hours. When buildings are not operational, coolers and freezers doors will be closed.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Small Business Improvement program, described in Section 15, and the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \Delta kWh/ft^2 \times A$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kWh}{HOU}$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
ΔkWh/ft^2 = average annual kilowatt hour savings per square foot of infiltration barrier
A = doorway area, ft^2
HOU = annual hours of use, hr/year

Input Variables

Table 68: Input Values for Strip Curtain Savings Calculations

Componen t	Type	Value	Unit	Source(s)
ΔkWh/yearft^2	Variable	See Table 69.	kWh/sq.ft.	Pennsylvania TRM 2016, p. 396 (Table 3-107)
A	Variable	Small Business Improvement: See customer application	sq.ft.	Customer application
		Default for Non-Residential Energy Audit, Small Business Improvement, and Non-Residential Prescriptive: Supermarkets: 35 Convenience Store: 21 Restaurant: 21 Refrigerated Warehouse: 80		Pennsylvania TRM 2016, p. 397, Table 3-108 (Supermarkets), Table 3-109 (Convenience Stores), Table 3-110 (Restaurant), Table 3-111 (Refrigerated Warehouse)
HOU	Fixed	8,760	hour/year	Pennsylvania TRM 2016, p. 394 (Table 3-107)

Table 69: Strip Curtain Gross Annual Electric Energy Savings (per Square Foot)[221]

Type	Pre-Existing Curtain	Gross Annual Electric Energy Savings per Square Foot (ΔkWh/ year·ft^2)
Supermarket - Cooler	Yes	37
Supermarket - Cooler	No	108
Supermarket - Cooler	Unknown	108
Supermarket - Freezer	Yes	119
Supermarket - Freezer	No	349
Supermarket - Freezer	Unknown	349
Convenience Store - Cooler	Yes	5
Convenience Store - Cooler	No	20
Convenience Store - Cooler	Unknown	11
Convenience Store - Freezer	Yes	8
Convenience Store - Freezer	No	27
Convenience Store - Freezer	Unknown	17
Restaurant - Cooler	Yes	8
Restaurant - Cooler	No	30
Restaurant - Cooler	Unknown	18
Restaurant - Freezer	Yes	34
Restaurant - Freezer	No	119
Restaurant - Freezer	Unknown	81
Refrigerated Warehouse	Yes	254
Refrigerated Warehouse	No	729
Refrigerated Warehouse	Unknown	287
Other[222]	Yes	5
Other	No	20
Other	Unknown	11
Not applicable	Yes	0
Not applicable	No	0
Not applicable	Unknown	0

[221] Pennsylvania TRM 2016, p. 400. "The assumption is based on general observation that refrigeration is constant for food storage, even outside of normal conditions. The most conservative approach, in lieu of a more sophisticated model, is based on continuous operation [8,760 hours/year of operation]."

[222] Assigned most conservative savings and reductions values for a known building subcategory.

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values. However, per Table 69 above, the gross annual electric energy savings per ft^2 varies widely based on the space type, therefore the default savings must be calculated for individual space types obtained from the application.

The default gross annual electric energy savings for the Convenience Store - Cooler will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{\Delta kWh/year}{ft^2} \times A$$

$$= 5\ kWh/ft^2/year\ \times 21\ ft^2$$

$$= 105\ kWh/year$$

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\Delta kW = \frac{\Delta kWh/year}{HOU}$$

$$= \frac{105\ kWh/year}{8{,}760\ hour/year}$$

$$= 0.012\ kW$$

Source(s)

The primary source for this deemed savings approach is the Pennsylvania TRM 2016, p. 393 - 401.

11.3.10 Suction Pipe Insulation (Cooler and Freezer)

Measure Description

This measure realizes energy savings by installing insulation on existing bare suction lines (lines that run from evaporator to compressor) that are located outside of the refrigerated space.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{\Delta kWh}{ft} \times L$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kW}{ft} \times L$$

Where:

ΔkWh/year = gross annual electric energy savings, kWh/year
ΔkW = gross coincident demand reductions, kW
ΔkWh/ft = gross annual electric energy savings per linear foot, kWh/ft
ΔkW/ft = gross coincident demand reductions per linear foot, kW/ft
L = length of insulation applied in linear feet, ft

Input Variables

Table 70: Input Values for Suction Pipe Insulation Savings Calculations

Component	Type	Value	Unit	Source(s)
ΔkWh/year ·ft	Variable	See Table 71	kWh/feet -year	Pennsylvania TRM 2016, p. 418
ΔkW/ft	Variable	See Table 71	kW/feet-year	Pennsylvania TRM 2016, p. 414
L	Variable	See customer application	feet	Customer application
		Default = 1		Per unit savings

Table 71: Suction Pipe Insulation Gross Annual Electric Energy and Gross Coincident Demand Reductions (per Linear Foot)[223]

Refrigeration Type	ΔkWh/year·ft	ΔkW/ft
Low Temperature (-35°F - -1°F)	14.8	0.002726
Medium Temperature (0°F - 30°F)	11.3	0.00219
High Temperature (31°F - 55°F)	11.3	0.00219

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{\Delta kWh/year}{ft} \times L$$

$$= 11.3\, kWh/ft/year \times 1\, ft$$

$$= 11.3\, kWh/year$$

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\Delta kW = \frac{\Delta kW}{ft} \times L$$

$$= 0.00219\, kW/ft \times 1ft$$

$$= 0.00219\, kW$$

Source(s)

The primary source for this deemed savings approach is the Pennsylvania TRM 2015, p. 419 – 420.

[223] Pennsylvania TRM 2016, p. 418, original source: Southern California Edison Company, "Insulation of Bare Refrigeration Suction Lines", Work Paper WPSCNRRN0003.

11.3.11 Vending Machine Miser

Measure Description

This measure realizes energy savings by installing vending misers that control the vending machine lighting and refrigeration systems power consumption of distributed closed-door cases. Miser controls power down these systems during periods of inactivity while ensuring that the product stays cold. Qualifying machines include glass front refrigerated coolers, non-refrigerated snack vending machines, and refrigerated beverage vending machines, but this measure does not apply to ENERGY STAR® vending machines that have built-in internal controls or distributed open door cases.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = kW_{rated} \times HOU \times ESF$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kWh}{8{,}760}$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
kW_{rated} = rated kilowatts of connected equipment
HOU = annual operating hours, hr/year
ESF = energy savings factor

Input Variables

Table 72: Input Values for Vending Miser Savings Calculations

Component	Type	Value	Unit	Source(s)
kW_{rated}	Variable	See customer application.	kW	Customer application
		Default: Non-Refrigerated Snack Vending Machine, see Table 73.		Massachusetts TRM 2013, p. 213. Default: Assigned most conservative value
ESF	Variable	See Table 73.	-	Massachusetts TRM 2013, p. 213
HOU	Fixed	8,760	hours/year	Massachusetts TRM 2014, p. 267

Table 73: Vending Miser Rated Kilowatts and ESFs[224]

Equipment Type	kW_{rated} (kW)	ESF
Refrigerated Beverage Vending Machine	0.40	0.46
Non-Refrigerated Snack Vending Machine	0.085	0.46
Glass Front Refrigerated Cooler	0.46	0.30

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be applied according to the following calculation:

$$\Delta kWh/year = kW_{rated} \times HOU \times ESF$$
$$= 0.085\ kw \times 8{,}760\ hours/year \times 0.46$$
$$= 343\ kWh/year$$

The default gross coincident demand reductions will be applied according to the following calculation:

$$\Delta kW = \frac{\Delta kWh/year}{HOU}$$
$$= \frac{343\ kWh/year}{8{,}760\ hours/year}$$
$$= 0.039\ kW$$

[224] Massachusetts TRM 2014. Original source is USA Technologies Energy Management Product Sheets (2006). https://www.usatech.com/energy_management/energy_productsheets.php (accessed on April 18, 2012.).

Source(s)

The primary source for this deemed savings approach is the Massachusetts TRM 2013, p. 213 – 215.

11.3.12 Zero-Heat Reach-In Glass Door

Measure Description

This measure realizes energy savings by replacing standard cooler doors with zero-energy doors and frames on reach-in refrigeration cases. These replacement doors consist of two or three panes of glass and include low-conductivity filler gas and low-emissivity glass coatings. They keep the outer glass warm and prevent external condensation. Standard reach-in coolers with glass doors have electric resistance heaters installed within the doors and frames. Refrigerator door manufacturers include these resistance heaters to prevent condensation from forming on the glass and to prevent frost formation on door frames.

Freezers are not eligible for this measure.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \Delta kW \times HOU$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = kW_{door} \times BF$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
HOU = annual operating hours, hr/year
kW_{door} = connected load in kW of a typical reach-in cooler door and frame with electric heaters[225]

BF = bonus factor for reduced cooling load from eliminating heat generated by the door heater from entering the cooler[226]

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[225] Vermont TRM. "Based on range of wattages from manufacturers data (115 to 215 watts per door and frame heaters combined)".

[226] Vermont TRM. "Bonus factor (1 + 0.65 / COPR + 0.35 x 0.75 x 0.29 / 2.5) assumes 3.5 COPR for medium temp and 5.4 COPR for high temp, based on the average standard reciprocating and discus compressor efficiencies with Saturated Suction Temperature of 20°F and 45°F, respectively, and a condensing temperature of 90°F, and EVT assumption that 65% of heat generated by door enters the refrigerated case. It further assumes that 75% of stores have mechanical cooling, where the remaining 35% of heat that enters the store must also be cooled, with a typical 2.5 COP cooling system efficiency and 0.29 ASHRAE Lighting waste heat cooling factor from Vermont (from "Calculating lighting and HVAC interactions", Table 1, ASHRAE Journal Nov. 1993).

Input Variables

Table 74: Input Values for Zero-Heat Reach-In Glass Door Savings Calculations

Component	Type	Value	Unit	Source(s)
HOU	Fixed	8,760	hours/ year	Vermont TRM 2015, p. 154
kW_{door}	Variable	See customer application.	kW	Customer application
		Default = 0.131		Vermont TRM 2015, p. 154
BF	Fixed	Low Temp (-35°F to -1°F): 1.22 Med Temp (0°F to 30°F): 1.22 High Temp (31°F to 55°F): 1.15	-	Vermont TRM 2015, p. 154

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross coincident peak demand reduction will be assigned according to the following calculation:

$$\Delta kW = kW_{door} \times BF$$

$$= 0.131\ kW \times 1.15$$

$$= 0.151\ kW$$

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \Delta kW \times HOU$$

$$= 0.151 kW \times 8{,}760\ hour/year$$

$$= 1{,}323\ kWh/year$$

Source(s)

The primary source for this deemed savings approach is the Vermont TRM 2015, p. 154.

11.4 Heating Ventilation and Air Conditioning (HVAC) End Use

11.4.1 Dual Enthalpy Air-side Economizer Repair

This measure is offered under the Virginia Non-Residential Heating and Cooling Efficiency program as a new installation (section 0), in the Non-Residential Energy Audit program as a retrofit and in the Non-Residential Small Business Improvement program (section 15) as either new installation or retrofit. They all use the same protocol provided below.

Measure Description

This measure realizes energy savings by repairing dual enthalpy economizers to provide free cooling during the appropriate ambient conditions. This measure applies only to retrofits. The baseline condition is the existing HVAC system with a malfunctioning dual enthalpy economizer control, that acts effectively as a system without an economizer. The efficient condition is the HVAC system with a properly functioning dual enthalpy economizer control.

The baseline condition is the existing HVAC system with a malfunctioning dual enthalpy economizer control, that acts effectively as a system without an economizer. The efficient condition is the HVAC system with a properly functioning dual enthalpy economizer control.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = Tons \times SF$$

Gross coincident demand reductions are assigned as follows:

$$\Delta kW^{227} = 0$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
Tons = HVAC system tonnage capacity
SF[228] = savings factor for the installation of dual enthalpy economizer control [kWh/ton]

Demand savings are assumed to be zero because the economizer will typically not be operating during the peak period.

[227] Ohio TRM, p. 261. Based on assumption that humidity levels will most likely be relatively high during the peak period, thereby reducing the likelihood of demand savings from door heater controls.

[228] "kWh/ton savings from "New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs", TecMarket Works, October 15, 2010, scaled based on enthalpy data from New York City and Mid-Atlantic cities from Typical Meteorological Year 3 (TMY3) data published by the National Renewable Energy Laboratory."