

4.5 Lighting End Use

The commercial lighting measures use a standard set of variables for hours or use, waste heat factors, coincident factors and HVAC interaction effects. This table has been developed based on information provided by the various stakeholders. For ease of review, the table is included here and referenced in each measure.

Building Type	Fixture Annual Operating Hours ³⁸⁹	Screw based bulb Annual Operating hours ³⁹⁰	Waste Heat Cooling Energy WHFe ³⁹¹	Waste Heat Cooling Demand WHFd ³⁹²	Coincidence Factor CF ³⁹³	Waste Heat Gas Heating IFTherms ³⁹⁴	Waste Heat Electric Resistance Heating IFkWh ³⁹⁵	Waste Heat Electric Heat Pump Heating IFkWh
Office	4,439	3,088	1.25	1.30	0.66	0.016	0.366	0.183
Grocery	5,802	3,650	1.43	1.52	0.69	0.012	0.274	0.137
Healthcare Clinic	5,095	4,207	1.34	1.57	0.75	0.008	0.183	0.091
Hospital	6,038	4,207	1.35	1.69	0.75	0.011	0.251	0.126
Heavy Industry	5,041	2,629	1.03	1.06	0.89	0.008	0.183	0.091
Light Industry	5,360	2,629	1.03	1.06	0.92	0.008	0.183	0.091

³⁸⁹ Fixtures hours of use are primarily derived from the default EPY4 values developed for ComEd based on DEER 2005, DEER 2008, EPY1 and EPY2 evaluation results. 'Lighting intro wp.doc'. Values for office, grocery, light industry, restaurant, retail/service and warehouse are an average of the EPY4 values and AmerEn Missouri, March 2011 Final Report: Evaluation of Business Energy Efficiency Program Custom and Standard Incentives. Hotel/Motel common areas is the DEER 2008 average across all non-guest room spaces and guest rooms is the average of hotel and motel guest room values from DEER 2008. Elementary School is from Ameren Missouri evaluation results. Multi-family common area value based on Focus on Energy Evaluation, ACES Deemed Savings Desk Review, November 2010. Miscellaneous is an average of all indoor spaces.

³⁹⁰ Hours of use for screw based bulbs are derived from DEER 2008 by building type for cfls. Garage, exterior and multi-family common area values are from the Hours of Use Table in this document. Miscellaneous is an average of interior space values. Some building types are averaged when DEER has two values: these include office, restaurant and retail. Healthcare clinic uses the hospital value.

³⁹¹ The Waste Heat Factor for Energy is developed using EQuest models for various building types averaged across 5 climate zones for Illinois for the following building types: office, grocery, healthcare/clinic, manufacturing, motel, high school, hospital, elementary school, restaurant, retail, college and warehouse. Exterior and garage values are 1, miscellaneous is an average of all indoor spaces.

³⁹² Waste Heat Factor for Demand is developed using EQuest models consistent with methodology for Waste Heat Factor for Energy.

³⁹³ Coincident diversity factors are from the EPY4 values developed for ComEd based on DEER 2005, DEER 2008, EPY1 and EPY2 evaluation results. Miscellaneous value for Coincident Diversity Factor is from DEER 2008.

³⁹⁴ IF Therms value is developed using EQuest models consistent with methodology for Waste Heat Factor for Energy.

³⁹⁵ Electric heat penalty assumptions are based on converting the IFTherm multiplier value in to kWh and then applying relative heating system efficiencies. The gas efficiency was assumed to be 78% AFUE based upon standard TRM assumption for existing unit average efficiency, and the electric resistance is assumed to be 100%:

$$\text{IFElectricHeat} = \text{IFTherms} * 29.3 \text{ kWh/therm} * 78\% \text{ (Gas Heating Equipment Efficiency)} / 100\% \text{ (Electric Resistance Efficiency)}$$

Building Type	Fixture Annual Operating Hours ³⁸⁹	Screw based bulb Annual Operating hours ³⁹⁰	Waste Heat Cooling Energy WHFe ³⁹¹	Waste Heat Cooling Demand WHFd ³⁹²	Coincidence Factor CF ³⁹³	Waste Heat Gas Heating IFTherms ³⁹⁴	Waste Heat Electric Resistance Heating IFkWh ³⁹⁵	Waste Heat Electric Heat Pump Heating IFkWh
Hotel/Motel Common Areas	5,311	4,542	1.15	1.51	0.21	0.022	0.503	0.251
Hotel/Motel Guest Rooms	777	777	1.15	1.51	0.21	0.022	0.503	0.251
High School/Middle School	4,311	2,327	1.23	0.74	0.22	0.017	0.389	0.194
Elementary School	2,422	2,118	1.21	1.33	0.22	0.019	0.434	0.217
Restaurant	3,673	4,784	1.34	1.65	0.80	0.023	0.526	0.263
Retail/Service	4,719	2,935	1.24	1.44	0.83	0.024	0.549	0.274
College/University	3,540	2,588	1.14	1.50	0.56	0.021	0.480	0.240
Warehouse	4,746	4,293	1.16	1.17	0.7	0.015	0.343	0.171
Garage	3,540	3,540	1.00	1.00	1.00	0.000	0.000	0.000
Garage, 24/7 lighting ³⁹⁶	8,766	8,766	1.00	1.00	1.00	0.000	0.000	0.000
Exterior	4,903	4,903	1.00	1.00	0.00	0.000	0.000	0.000
Multi-family Common Areas	5,950	5,950	1.34	1.57	0.75	0.015	0.343	0.171
Religious Worship/Church ³⁹⁷	1,664	1,664	1.24	1.46	0.66	0.014	0.320	0.160
Low-Use Business ³⁹⁸ Small	2,954	2,954	1.24	1.46	0.66	0.014	0.320	0.160

³⁹⁶ As above except Heat Pump efficiency is assumed to be 200%.

³⁹⁷ Religious worship/church hours are based on DOE 2003 Commercial Building Energy Survey (CBECS) assumption of 32 hours 52 weeks a year. Coincident factor is estimated based on assumption that system peak times (1-5pm M-F) are not likely to be heavy usage periods for religious buildings. Other assumptions are consistent with miscellaneous assumptions.

³⁹⁸ Low-use small business hours are based on ComEd EPY4 Small Business Energy Savings Evaluation. Other assumptions are consistent with Miscellaneous assumptions.

Building Type	Fixture Annual Operating Hours ³⁸⁹	Screw based bulb Annual Operating hours ³⁹⁰	Waste Heat Cooling Energy WHFe ³⁹¹	Waste Heat Cooling Demand WHFd ³⁹²	Coincidence Factor CF ³⁹³	Waste Heat Gas Heating IFtherms ³⁹⁴	Waste Heat Electric Resistance Heating IFkWh ³⁹⁵	Waste Heat Electric Heat Pump Heating IFkWh
Miscellaneous ³⁹⁹	4,576	3,198	1.24	1.46	0.66	0.014	0.320	0.160
Uncooled Building	Varies	varies	1.00	1.00	varies	varies	varies	varies
Refrigerated Cases	5,802	n/a	1.29	1.29	0.69	0	0.000	0.000
Freezer Cases	5,802	n/a	1.5	1.5	0.69	0	0.000	0.000

³⁹⁹ Miscellaneous hours are based on an average of all other space types. Values for EIF, DIF and IFtherms are an average of the other values excluding garage, uncooled building and exterior. Coincident Diversity Factor is from DEER 2008

4.5.1 Commercial ENERGY STAR Compact Fluorescent Lamp (CFL)

DESCRIPTION

A low wattage ENERGY STAR qualified compact fluorescent screw-in bulb (CFL) is installed in place of a baseline screw-in bulb. This characterization assumes that the CFL is installed in a commercial location. If the implementation strategy does not allow for the installation location to be known a deemed split should be used. For Residential targeted programs (e.g. an upstream retail program), a deemed split of 97% Residential and 3% Commercial assumptions should be used⁴⁰⁰, and for Commercial targeted programs a deemed split of 17% Residential and 83% Commercial should be used⁴⁰¹.

Federal legislation stemming from the Energy Independence and Security Act of 2007 (EISA) required all general-purpose light bulbs between 40W and 100W to be approximately 30% more energy efficient than current incandescent bulbs. Production of 100W, standard efficacy incandescent lamps ended in 2012 followed by restrictions on 75W in 2013 and 60W and 40W in 2014. The baseline for this measure has therefore become bulbs (improved incandescent or halogen) that meet the new standard.

Finally, a provision in the EISA regulations requires that by January 1, 2020, all lamps meet efficiency criteria of at least 45 lumens per watt, in essence making the baseline equivalent to a current day CFL. Therefore the measure life (number of years that savings should be claimed) should be reduced once the assumed lifetime of the bulb exceeds 2020. Due to expected delay in clearing retail inventory and to account for the operating life of a halogen incandescent potentially spanning over 2020, this shift is assumed not to occur until mid-2020.

This measure was developed to be applicable to the following program types: TOS, NC, RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the high-efficiency equipment must be a standard ENERGY STAR qualified compact fluorescent lamp.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be an EISA qualified incandescent or halogen as provided in the table provided in the Electric Energy Savings section.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life (number of years that savings should be claimed) should be calculated by dividing the rated life of the bulb (10,000 hours⁴⁰²) by the run hours. For example using Miscellaneous at 4,589 hours would give 2.2 years. When the number of years exceeds June 2020, the number of years to that date should be used.

⁴⁰⁰ RES v C&I split is based on a weighted (by sales volume) average of ComEd PY3, PY4 and PY5 and Ameren PY5 in store intercept survey results.

⁴⁰¹ Based upon weighted (by sales volume) average of the BILD program (ComEd's commercial lighting program) for PY 4 and PY5.

⁴⁰² Energy Star bulbs have a rated life of at least 8000 hours. In commercial settings you expect significantly less on/off switching than residential and so a rated life assumption of 10,000 hours is used.

DEEMED MEASURE COST

The incremental capital cost assumption for all bulbs under 2600 lumens is \$1.25, from June 2014 – May 2015, \$1.6 from June 2015 to May 2016 and \$1.70 from June 2017 to May 2018⁴⁰³.

For bulbs over 2600 lumens the assumed incremental capital cost is \$5.

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in section 4.5.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta \text{kWh} = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{Hours} * \text{WHFe}$$

Where:

WattsBase = Actual (if retrofit measure) or based on lumens of CFL bulb and program year installed:

⁴⁰³ Based upon pricing forecast developed by Applied Proactive Technologies Inc (APT) based on industry input and provided to Ameren.

Minimum Lumens	Maximum Lumens	Incandescent Equivalent Post-EISA 2007 (WattsBase)
5280	6209	300
3000	5279	200
2601	2999	150
1490	2600	72
1050	1489	53
750	1049	43
310	749	29
250	309	25

WattsEE = Actual wattage of CFL purchased or installed

ISR = In Service Rate or the percentage of units rebated that get installed.
 =100%⁴⁰⁴ if application form completed with sign off that equipment is not placed into storage

If sign off form not completed assume the following 3 year ISR assumptions:

Weighted Average 1 st year In Service Rate (ISR)	2 nd year Installations	3 rd year Installations	Final Lifetime In Service Rate
75.5% ⁴⁰⁵	12.1%	10.3%	98.0% ⁴⁰⁶

Hours = Average hours of use per year are provided in Reference Table in Section 4.5, Screw based bulb annual operating hours, for each building type⁴⁰⁷. If unknown use the Miscellaneous value.

⁴⁰⁴ Illinois evaluation of PY1 through PY3 has not found that fixtures or lamps placed into storage to be a significant enough issue to warrant including an “In-Service Rate” when commercial customers complete an application form.

⁴⁰⁵ 1st year in service rate is based upon review of PY4-5 evaluations from ComEd’s commercial lighting program (BILD) (see ‘IL Commercial Lighting ISR.xls’ for more information. The average first year ISR was calculated weighted by the number of bulbs sold.

⁴⁰⁶ The 98% Lifetime ISR assumption is based upon review of two evaluations:

‘Nexus Market Research, RLW Analytics and GDS Associates study; “New England Residential Lighting Markdown Impact Evaluation, January 20, 2009’ and ‘KEMA Inc, Feb 2010, Final Evaluation Report:, Upstream Lighting Program, Volume 1.’ This implies that only 2% of bulbs purchased are never installed. The second and third year installations are based upon Ameren analysis of the Californian KEMA study showing that 54% of future installs occur in year 2 and 46% in year 3. The 2nd and 3rd year installations should be counted as part of those future program year savings.

⁴⁰⁷ Based on ComEd analysis taking DEER 2008 values and averaging with PY1 and PY2 evaluation results.

WHFe = Waste heat factor for energy to account for cooling energy savings from efficient lighting are provided below for each building type in Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, a 14W standard CFL is installed in an office in 2014 and sign off form provided:

$$\begin{aligned}\Delta kWh &= (((43 - 14)/1000) * 1.0 * 3088 * 1.25 \\ &= 111.9 \text{ kWh}\end{aligned}$$

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{408} = (((\text{WattsBase} - \text{WattsEE})/1000) * \text{ISR} * \text{Hours} * -\text{IFkWh})$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, a 14W standard CFL is installed in a heat pump heated office in 2014 and sign off form provided:

$$\begin{aligned}\Delta kWh_{\text{heatpenalty}} &= (((43 - 14)/1000) * 1.0 * 3088 * -0.183 \\ &= - 16.4 \text{ kWh}\end{aligned}$$

DEFERRED INSTALLS

As presented above, if a sign off form is not completed the characterization assumes that a percentage of bulbs purchased are not installed until Year 2 and Year 3 (see ISR assumption above). The Illinois Technical Advisory Committee has determined the following methodology for calculating the savings of these future installs.

Year 1 (Purchase Year) installs: Characterized using assumptions provided above or evaluated assumptions if available.

Year 2 and 3 installs: Characterized using delta watts assumption and hours of use from the Install Year i.e. the actual deemed (or evaluated if available) assumptions active in Year 2 and 3 should be applied.

The NTG factor for the Purchase Year should be applied.

⁴⁰⁸ Negative value because this is an increase in heating consumption due to the efficient lighting.

For example, for a 14W CFL (60W standard incandescent and 43W EISA qualified incandescent/halogen) purchased in 2014 and using miscellaneous hours assumption.

$$\begin{aligned}\Delta\text{kWh}_{1\text{st year installs}} &= ((43 - 14) / 1000) * 0.755 * 3198 * 1.06 \\ &= 74.2 \text{ kWh}\end{aligned}$$

$$\begin{aligned}\Delta\text{kWh}_{2\text{nd year installs}} &= ((43 - 14) / 1000) * 0.121 * 3198 * 1.06 \\ &= 11.9 \text{ kWh}\end{aligned}$$

Note: Here we assume no change in hours assumption. NTG value from Purchase year applied.

$$\begin{aligned}\Delta\text{kWh}_{3\text{rd year installs}} &= ((43 - 14) / 1000) * 0.103 * 3198 * 1.06 \\ &= 10.1 \text{ kWh}\end{aligned}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta\text{kW} = ((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{WHFd} * \text{CF}$$

Where:

WHFd = Waste heat factor for demand to account for cooling savings from efficient lighting in cooled buildings is provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value..

CF = Summer Peak Coincidence Factor for measure is provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value..

Other factors as defined above

For example, a 14W standard CFL is installed in an office in 2014 and sign off form provided:

$$\begin{aligned}\Delta\text{kW} &= ((43 - 14)/1000)*1.0*1.3*0.66 \\ &= 0.025\text{kW}\end{aligned}$$

NATURAL GAS ENERGY SAVINGS

Heating Penalty if fossil fuel heated building (or if heating fuel is unknown):

$$\Delta\text{Therms}^{409} = (((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * - \text{IFTherms}$$

Where:

⁴⁰⁹ Negative value because this is an increase in heating consumption due to the efficient lighting.

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

Other factors as defined above

For example, a 14W standard CFL is installed in an office in 2014 and sign off form provided:

$$\begin{aligned} \Delta\text{Therms} &= (((43 - 14)/1000) * 1.0 * 3088 * -0.016 \\ &= - 1.4 \text{ Therms} \end{aligned}$$

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

Bulb replacement costs assumed in the O&M calculations are provided below⁴¹⁰.

	Std Inc.	EISA Compliant Halogen
2014	\$0.34	\$1.25
2015	\$0.34	\$0.90
2016	\$0.34	\$0.80
2017	\$0.34	\$0.70
2018	\$0.34	\$0.60
2019	\$0.34	\$0.60
2020 & after	\$0.34	N/A

In order to account for the falling EISA Qualified bulb replacement cost provided above, an equivalent annual levelized baseline replacement cost over the lifetime of the CFL bulb is calculated. Note that the measure life for these measures is capped to the number of years remaining until 2020.

The NPV for replacement lamps and annual levelized replacement costs using the statewide real discount rate of 5.23% are presented below:

⁴¹⁰ Based upon pricing forecast developed by Applied Proactive Technologies Inc (APT) based on industry input and provided to Ameren.

Location	Lumen Level	NPV of replacement costs for period			Levelized annual replacement cost savings		
		June 2014 - May 2015	June 2015 - May 2016	June 2016 - May 2017	June 2014 - May 2015	June 2015 - May 2016	June 2016 - May 2017
Commercial	Lumens <310 or >2600 (EISA exempt)	\$2.83	\$2.83	\$2.83	\$1.40	\$1.40	\$1.40
	Lumens ≥ 310 and ≤ 2600 (EISA compliant)	\$8.60	\$6.91	\$6.08	\$4.26	\$3.43	\$3.02

For halogen bulbs, we assume the same replacement cycle as incandescent bulbs.⁴¹¹ The replacement cycle is based on the miscellaneous hours of use. Both incandescent and halogen lamps are assumed to last for 1,000 hours before needing replacement.

MEASURE CODE: CI-LTG-CCFL-V03-140601

⁴¹¹ The manufacturers of the new minimally compliant EISA Halogens are using regular incandescent lamps with halogen fill gas rather than halogen infrared to meet the standard and so the component rated life is equal to the standard incandescent.

4.5.2 Fluorescent Delamping

DESCRIPTION

This measure addresses the permanent removal of existing 8', 4', 3' and 2' fluorescent lamps. Unused lamps, lamp holders, and ballasts must be permanently removed from the fixture. This measure is applicable when retrofitting from T12 lamps to T8 lamps or simply removing lamps from a T8 fixture. Removing lamps from a T12 fixture that is not being retrofitted with T8 lamps are not eligible for this incentive.

Customers are responsible for determining whether or not to use reflectors in combination with lamp removal in order to maintain adequate lighting levels. Lighting levels are expected to meet the Illuminating Engineering Society of North America (IESNA) recommended light levels. Unused lamps, lamp holders, and ballasts must be permanently removed from the fixture and disposed of in accordance with local regulations. A pre-approval application is required for lamp removal projects.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

Savings are defined on a per removed lamp basis. The retrofit wattage (efficient conditioned) is therefore assumed to be zero. The savings numbers provided below are for the straight lamp removal measures, as well as the lamp removal and install reflector measures. The lamp installed/retrofit is captured in another measure.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is either a T12 or a T8 lamp with default wattages provided below. Note, if the program does not allow for the lamp type to be known, then a T12:T8 weighting of 80%:20% can be applied⁴¹².

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 11 years per DEER 2005.

DEEMED MEASURE COST

The incremental capital cost is provided in the table below:

⁴¹² Based on ComEd's estimate of lamp type saturation.

Measure Category	Value	Source
8-Foot Lamp Removal	\$16.00	ComEd/KEMA regression ⁴¹³
4-Foot Lamp Removal	\$12.00	ICF Portfolio Plan
8-Foot Lamp Removal with reflector	\$30.00	KEMA Assumption
4-Foot Lamp Removal with reflector	\$25.00	KEMA Assumption
2-Foot or 3-Foot Removal	\$12.35	KEMA Assumption
2-Foot or 3-Foot Removal with reflector	\$25.70	KEMA Assumption

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in the reference section below.

⁴¹³ Based on the assessment of active projects in the 2008-09 ComEd Smart Ideas Program. See files “ltg costs 12-10-10.xl.” and “Lighting Unit Costs 102605.doc”

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ((WattsBase - WattsEE) / 1000) * ISR * Hours * WHFe$$

Where:

WattsBase = Assume wattage reduction of lamp removed

	Wattage of lamp removed ⁴¹⁴		Weighted average
	T8	T12	80% T12, 20% T8
8-ft T8	38.6	60.3	56.0
4-ft T8	19.4	33.7	30.8
3-ft T8	14.6	40.0	34.9
2-ft T8	9.8	28.0	24.4

WattsEE = 0

ISR = In Service Rate or the percentage of units rebated that get installed.

=100% if application form completed with sign off that equipment permanently removed and disposed of.

Hours = Average hours of use per year are provided in Reference Table in Section 4.5. If unknown use the Miscellaneous value.

WHFe = Waste heat factor for energy to account for cooling energy savings from efficient lighting are provided below for each building type in Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

⁴¹⁴ Default wattage reduction is based on averaging the savings from moving from a 2 to 1, 3 to 2 and 4 to 3 lamp fixture, as provided in the Standard Performance Contract Procedures Manual: Appendix B: Table of Standard Fixture Wattages (http://www.sce.com/NR/rdonlyres/7A3455F0-A337-439B-9607-10A016D32D4B/0/spc_B_Std_Fixture_Watts.pdf). An adjustment is made to the T8 delamped fixture to account for the significant increase in ballast factor. See 'Delamping calculation.xls' for details.

For example, delamping a 4 ft T8 fixture in an office building:

$$\begin{aligned} \Delta kWh &= ((19.4 - 0)/1000) * 1.0 * 4439 * 1.25 \\ &= 107.6 \text{ kWh} \end{aligned}$$

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{415} = (((\text{WattsBase} - \text{WattsEE})/1000) * \text{ISR} * \text{Hours} * -\text{IFkWh})$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, delamping a 4 ft T8 fixture in a heat pump heated office building:

$$\begin{aligned} \Delta kWh_{\text{heatpenalty}} &= ((19.4 - 0)/1000) * 1.0 * 4439 * -0.151 \\ &= -13.0 \text{ kWh} \end{aligned}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = ((\text{WattsBase} - \text{WattsEE})/1000) * \text{ISR} * \text{WHFd} * \text{CF}$$

Where:

WHFd = Waste heat factor for demand to account for cooling savings from efficient lighting in cooled buildings is provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value..

CF = Summer Peak Coincidence Factor for measure is provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value..

Other factors as defined above

⁴¹⁵Negative value because this is an increase in heating consumption due to the efficient lighting.

For example, delamping a 4 ft T8 fixture in an office building:

$$\begin{aligned} \Delta kWh &= ((19.4 - 0)/1000) * 1.0 * 1.3 * 0.66 \\ &= 0.017 \text{ kW} \end{aligned}$$

NATURAL GAS ENERGY SAVINGS

Heating Penalty if fossil fuel heated building (or if heating fuel is unknown):

$$\Delta \text{Therms}^{416} = (((\text{WattsBase} - \text{WattsEE})/1000) * \text{ISR} * \text{Hours} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Interaction Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

Other factors as defined above

For example, delamping a 4 ft T8 fixture in an office building:

$$\begin{aligned} \Delta \text{Therms} &= ((19.4 - 0)/1000) * 1.0 * 4439 * -0.016 \\ &= -1.4 \text{ therms} \end{aligned}$$

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-LTG-DLMP-V02-140601

⁴¹⁶ Negative value because this is an increase in heating consumption due to the efficient lighting.

4.5.3 High Performance and Reduced Wattage T8 Fixtures and Lamps

DESCRIPTION

This measure applies to “High Performance T8” (HPT8) lamp/ballast systems that have higher lumens per watt than standard T8 systems. This measure applies to the installation of new equipment with efficiencies that exceed that of the equipment that would have been installed following standard market practices and is applicable to time of sale as well as retrofit measures. Retrofit measures may include new fixtures or relamp/reballast measures. In addition, options have been provided to allow for the “Reduced Wattage T8 lamps” or RWT8 lamps that result in re-lamping opportunities that produce equal or greater light levels than standard T8 lamps while using fewer watts.

If the implementation strategy does not allow for the installation location to be known, a deemed split of 98% Commercial and 2% Residential should be used⁴¹⁷.

This measure was developed to be applicable to the following program types: TOS, RF.
If applied to other program types, the measure savings should be verified.

The measure applies to all commercial HPT8 installations excluding new construction and major renovation or change of use measures (see lighting power density measure). Lookup tables have been provided to account for the different types of installations. Whenever possible, actual costs and hours of use should be utilized for savings calculations. Default new and baseline assumptions have been provided in the reference tables. Default component costs and lifetimes have been provided for Operating and Maintenance Calculations. Please see the Definition Table to determine applicability for each program. HPT8 configurations not included in the TRM may be included in custom program design using the provided algorithms as long as energy savings is achieved. The following table defines the applicability for different programs

Time of Sale (TOS)	Retrofit (RF)
<p>This measure relates to the installation of new equipment with efficiency that exceeds that of equipment that would have been installed following standard market practices. In general, the measure will include qualifying high efficiency low ballast factor ballasts paired with high efficiency long life lamps as detailed in the attached tables. High-bay applications use this system paired with qualifying high ballast factor ballasts and high performance 32 w lamps. Custom lighting designs can use qualifying low, normal or high ballast factor ballasts and qualifying lamps in lumen equivalent applications where total system wattage is reduced when calculated using the Calculation of Savings Algorithms.</p>	<p>This measure relates to the replacement of existing equipment with new equipment with efficiency that exceeds that of the existing equipment. In general, the retrofit will include qualifying high efficiency low ballast factor ballasts paired with high efficiency long life lamps as detailed in the attached tables. Custom lighting designs can use qualifying low, normal or high ballast factor ballasts and qualifying lamps in lumen equivalent applications where total system wattage is reduced when calculated using the Calculation of Savings Algorithms.</p> <p>High efficiency troffers (new/or retrofit) utilizing HPT8 technology can provide even greater savings. When used in a high-bay application, high-performance T8 fixtures can provide equal light to HID high-bay fixtures, while using fewer watts; these systems typically utilize high</p>

⁴¹⁷ Based on ComEd’s BILD program data from PY5. For Residential installations, hours of use assumptions from ‘5.5 Interior Hardwired Compact Fluorescent Lamp (CFL) Fixture’ measure should be used.

Time of Sale (TOS)	Retrofit (RF)
	ballast factor ballasts, but qualifying low and normal ballast factor ballasts may be used when appropriate light levels are provided and overall wattage is reduced.

DEFINITION OF EFFICIENT EQUIPMENT

The definition of efficient equipment varies based on the program and is defined below:

Time of Sale (TOS)	Retrofit (RF)
<p>In order for this characterization to apply, new lamps and ballasts must be listed on the CEE website on the qualifying High Performance T8 lamps and ballasts list (http://www.cee1.org/com/com-lt/com-lt-main.php3).</p> <p>High efficiency troffers combined with high efficiency lamps and ballasts allow for fewer lamps to be used to provide a given lumen output. High efficiency troffers must have a fixture efficiency of 80% or greater to qualify. Default values are given for a 2 lamp HPT8 fixture replacing a 3 lamp standard efficiency T8 fixture, but other configurations may qualify and the Calculation of savings algorithm used to account for base watts being replaced with EE watts.</p> <p>High bay fixtures must have fixture efficiencies of 85% or greater.</p> <p>RWT8 lamps: In order for this characterization to apply, new 4' and U-tube lamps must be listed on the CEE website on the qualifying Reduced Wattage High Performance T8 lamps list. (http://library.cee1.org/content/commercial-lighting-qualifying-products-lists). 2', 3' and 8' lamps must meet the wattage requirements specified in the RWT8 new and baseline assumptions table. This measure assumes a lamp only purchase.</p>	<p>In order for this characterization to apply, new lamps and ballasts must be listed on the CEE website on the qualifying High Performance T8 lamps and ballasts list (http://www.cee1.org/com/com-lt/com-lt-main.php3).</p> <p>High efficiency troffers (new or retrofit kits) combined with high efficiency lamps and ballasts allow for fewer lamps to be used to provide a given lumen output. High efficiency troffers must have a fixture efficiency of 80% or greater to qualify. Default values are given for a 2 lamp HPT8 fixture replacing a 3 lamp standard efficiency T8 fixture, but other configurations may qualify and the Calculation of savings algorithm used to account for base watts being replaced with EE watts.</p> <p>High bay fixtures will have fixture efficiencies of 85% or greater.</p> <p>RWT8: in order for this characterization to apply, new 4' and U-tube lamps must be listed on the CEE website on the qualifying Reduced Wattage High Performance T8 lamps list. (http://library.cee1.org/content/commercial-lighting-qualifying-products-lists). 2', 3' and 8' lamps must meet the wattage requirements specified in the RWT8 new and baseline assumptions table.</p>

DEFINITION OF BASELINE EQUIPMENT

The definition of baseline equipment varies based on the program and is defined below:

Time of Sale (TOS)	Retrofit (RF)
<p>The baseline is standard efficiency T8 systems that would have been installed. The baseline for high-bay fixtures is pulse start metal halide fixtures, the baseline for a 2 lamp high efficiency troffer is a 3 lamp standard efficiency troffer.</p>	<p>The baseline is the existing system.</p> <p>Due to new federal standards for linear fluorescent lamps, manufacturers of T12 lamps will not be permitted to manufacture most varieties of T12 lamps for sale in the United States after July 2012. All remaining stock and previously manufactured product may be sold after the July 2012 effective date. If a customer relamps an existing T12 fixture the day the standard takes effect, an assumption can be made that they would likely need to upgrade to, at a minimum, 800-series T8s in less than 5 years' time. This assumes the T12s installed have a typical rated life of 20,000 hours and are operated for 4500 hours annually (average miscellaneous hours 4576/year). Certainly, it is not realistic that everyone would wait until the final moment to relamp with T12s. Also, the exempted T12 lamps greater than 87 CRI will continue to be available to purchase, although they will be expensive. Therefore the more likely scenario would be a gradual shift to T8s over the 4 year timeframe. In other words, we can expect that for each year between 2012 and 2016, ~20% of the existing T12 lighting will change over to T8 lamps that comply with the federal standard. To simplify this assumption, we recommend assuming that standard T8s become the baseline for all T12 linear fluorescent retrofit January 1, 2016. There will be a baseline shift applied to all measures installed before 2016. See table C-1.</p>

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed lifetime of efficient equipment varies based on the program and is defined below:

Time of Sale (TOS)	Retrofit (RF)
<p>Fixture lifetime is 15 years⁴¹⁸.</p> <p>Fixture retrofits which utilize RWT8 lamps have a lifetime equivalent to the life of the lamp, capped at 15 years. There is no guarantee that a reduced wattage lamp will be installed at time of burnout, but if one is, savings will be captured in the RWT8 measure below.</p> <p>RWT8 lifetime is the life of the product, at the reported operating hours (lamp life in hours divided by operating hours per year – see reference table "RWT8 Component Costs and Lifetime"), capped at 15 years.⁴¹⁹</p>	<p>Fixture lifetime is 15 years.</p> <p>As per explanation above, for existing T12 fixtures, a mid life baseline shift should be applied in Jan 2016 as described in table C-1.</p>

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

⁴¹⁸ 15 years from GDS Measure Life Report, June 2007

⁴¹⁹ *ibid*

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (Watts_{base} - Watts_{EE}) / 1000 * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$ = Input wattage of the existing system which depends on the baseline fixture configuration (number and type of lamp) and number of fixtures. Value can be selected from the appropriate reference table as shown below, of a custom value can be entered if the configurations in the tables is not representative of the existing system.

Program	Reference Table
Time of Sale	A-1: HPT8 New and Baseline Assumptions
Retrofit	A-2: HPT8 New and Baseline Assumptions
Reduced Wattage T8, time of sale or retrofit	A-3: RWT8 New and Baseline Assumptions

$Watts_{EE}$ = New Input wattage of EE fixture which depends on new fixture configuration (number of lamps) and ballast factor and number of fixtures. Value can be selected from the appropriate reference table as shown below, of a custom value can be entered if the configurations in the tables is not representative of the existing system.

Program	Reference Table
Time of Sale	A-1: HPT8 New and Baseline Assumptions
Retrofit	A-2: HPT8 New and Baseline Assumptions
Reduced Wattage T8, time of sale or retrofit	A-3: RWT8 New and Baseline Assumptions

Hours = Average hours of use per year as provided by the customer or selected from the Reference Table in Section 4.5, Fixture annual operating hours. If hours or building type are unknown, use the Miscellaneous value.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate or the percentage of units rebated that get installed.

=100%⁴²⁰ if application form completed with sign off that equipment is not placed into storage

If sign off form not completed assume the following 3 year ISR assumptions:

Weighted Average 1 st year In Service Rate (ISR)	2 nd year Installations	3 rd year Installations	Final Lifetime In Service Rate
96% ⁴²¹	1.1%	0.9%	98.0% ⁴²²

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{423} = (((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{Hours} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

SUMMER COINCIDENT DEMAND SAVINGS

$$\Delta kW = ((\text{Watts}_{\text{base}} - \text{Watts}_{\text{EE}}) / 1000) * \text{WHF}_d * \text{CF} * \text{ISR}$$

Where:

WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is selected from the Reference Table in Section 4.5 for each building type. If the building is not cooled WHF_d is 1.

⁴²⁰ Illinois evaluation of PY1 through PY3 has not found that fixtures or lamps placed into storage to be a significant enough issue to warrant including an “In-Service Rate” when commercial customers complete an application form.

⁴²¹ 1st year in service rate is based upon review of PY4-5 evaluations from ComEd’s commercial lighting program (BILD) (see ‘IL Commercial Lighting ISR.xls’ for more information

⁴²² The 98% Lifetime ISR assumption is based upon review of two evaluations:

‘Nexus Market Research, RLW Analytics and GDS Associates study; “New England Residential Lighting Markdown Impact Evaluation, January 20, 2009’ and ‘KEMA Inc, Feb 2010, Final Evaluation Report; Upstream Lighting Program, Volume 1.’ This implies that only 2% of bulbs purchased are never installed. The second and third year installations are based upon Ameren analysis of the Californian KEMA study showing that 54% of future installs occur in year 2 and 46% in year 3. The 2nd and 3rd year installations should be counted as part of those future program year savings.

⁴²³ Negative value because this is an increase in heating consumption due to the efficient lighting.

CF = Summer Peak Coincidence Factor for measure is selected from the Reference Table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

Other factors as defined above

NATURAL GAS SAVINGS

$$\Delta\text{Therms}^{424} = (((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Please select from the Reference Table in Section 4.5 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

See Reference tables for Operating and Maintenance Values

Program	Reference Table
Time of Sale	B-1: HPT8 Component Costs and Lifetime
Retrofit	B-2: HPT8 Component Costs and Lifetime
Reduced Wattage T8, time of sale or retrofit	B-3: HPT8 Component Costs and Lifetime

REFERENCE TABLES

See following page

⁴²⁴ Negative value because this is an increase in heating consumption due to the efficient lighting.

A-1: Time of Sale: HPT8 New and Baseline Assumptions⁴²⁵

EE Measure Description	Watts _{EE}	Baseline Description	Watts _{BASE}	Measure Cost	Watts _{SAVE}
4-Lamp HPT8 w/ High-BF Ballast High-Bay	146	200 Watt Pulse Start Metal-Halide	232	\$75	86
6-Lamp HPT8 w/ High-BF Ballast High-Bay	221	320 Watt Pulse Start Metal-Halide	350	\$75	129
8-Lamp HPT8 w/ High-BF Ballast High-Bay	280	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	455	\$75	175
1-Lamp HPT8-high performance 32 w lamp	25	1-Lamp Standard F32T8 w/ Elec. Ballast	32	\$15	7
1-Lamp HPT8-high performance 28 w lamp	22	1-Lamp Standard F32T8 w/ Elec. Ballast	32	\$15	10
1-Lamp HPT8-high performance 25 w lamp	19	1-Lamp Standard F32T8 w/ Elec. Ballast	32	\$15	13
2-Lamp HPT8-high performance 32 w lamp	49	2-Lamp Standard F32T8 w/ Elec. Ballast	59	\$18	10
2-Lamp HPT8-high performance 28 w lamp	43	2-Lamp Standard F32T8 w/ Elec. Ballast	59	\$18	16
2-Lamp HPT8-high performance 25 w lamp	35	2-Lamp Standard F32T8 w/ Elec. Ballast	59	\$18	24
3-Lamp HPT8-high performance 32 w lamp	72	3-Lamp Standard F32T8 w/ Elec. Ballast	88	\$20	16
3-Lamp HPT8-high performance 28 w lamp	65	3-Lamp Standard F32T8 w/ Elec. Ballast	88	\$20	23
3-Lamp HPT8-high performance 25 w lamp	58	3-Lamp Standard F32T8 w/ Elec. Ballast	88	\$20	30
4-Lamp HPT8-high performance 32 w lamp	94	4-Lamp Standard F32T8 w/ Elec. Ballast	114	\$23	20
4-Lamp HPT8-high performance 28 w lamp	86	4-Lamp Standard F32T8 w/ Elec. Ballast	114	\$23	28
4-Lamp HPT8-high performance 25 w lamp	77	4-Lamp Standard F32T8 w/ Elec. Ballast	114	\$23	37
2-lamp High-Performance HPT8 Troffer	49	3-Lamp F32T8 w/ Elec. Ballast	88	\$100	39

Table developed using a constant ballast factor of .77. Input wattages are an average of manufacturer inputs that account for ballast efficacy

⁴²⁵ Adapted from Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011.

A-2: Retrofit HPT8 New and Baseline Assumptions⁴²⁶ (Note see definition for validity after 2016)

EE Measure Description	Watts _{EE}	Baseline Description	Watts _{BASE}	Incremental cost	Watts _{SAVE}
4-Lamp HPT8 w/ High-BF Ballast High-Bay	146	200 Watt Pulse Start Metal-Halide	232	\$200	86
4-Lamp HPT8 w/ High-BF Ballast High-Bay	146	250 Watt Metal Halide	295	\$200	149
6-Lamp HPT8 w/ High-BF Ballast High-Bay	206	320 Watt Pulse Start Metal-Halide	350	\$225	144
6-Lamp HPT8 w/ High-BF Ballast High-Bay	206	400 Watt Metal Halide	455	\$225	249
8-Lamp HPT8 w/ High-BF Ballast High-Bay	280	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	476	\$250	196
8-Lamp HPT8 w/ High-BF Ballast High-Bay	280	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 400 W Metal halide	618	\$250	338
1-Lamp Relamp/Reballast T12 to HPT8	25	1-Lamp F34T12 w/ EEMag Ballast	40	\$50	15
2-Lamp Relamp/Reballast T12 to HPT8	49	2-Lamp F34T12 w/ EEMag Ballast	68	\$55	19
3-Lamp Relamp/Reballast T12 to HPT8	72	3-Lamp F34T12 w/ EEMag Ballast	110	\$60	38
4-Lamp Relamp/Reballast T12 to HPT8	94	4-Lamp F34T12 w/ EEMag Ballast	139	\$65	45
1-Lamp Relamp/Reballast T12 to HPT8	25	1-Lamp F40T12 w/ EEMag Ballast	48	\$50	23
2-Lamp Relamp/Reballast T12 to HPT8	49	2-Lamp F40T12 w/ EEMag Ballast	82	\$55	33
3-Lamp Relamp/Reballast T12 to HPT8	72	3-Lamp F40T12 w/ EEMag Ballast	122	\$60	50
4-Lamp Relamp/Reballast T12 to HPT8	94	4-Lamp F40T12 w/ EEMag Ballast	164	\$65	70
1-Lamp Relamp/Reballast T12 to HPT8	25	1-Lamp F40T12 w/ Mag Ballast	57	\$50	32
2-Lamp Relamp/Reballast T12 to HPT8	49	2-Lamp F40T12 w/ Mag Ballast	94	\$55	45
3-Lamp Relamp/Reballast T12 to HPT8	72	3-Lamp F40T12 w/ Mag Ballast	147	\$60	75
4-Lamp Relamp/Reballast T12 to HPT8	94	4-Lamp F40T12 w/ Mag Ballast	182	\$65	88
1-Lamp Relamp/Reballast T8 to HPT8	25	1-Lamp F32T8 w/ Elec. Ballast	32	\$50	7
2-Lamp Relamp/Reballast T8 to HPT8	49	2-Lamp F32T8 w/ Elec. Ballast	59	\$55	10
3-Lamp Relamp/Reballast T8 to HPT8	72	3-Lamp F32T8 w/ Elec. Ballast	88	\$60	16
4-Lamp Relamp/Reballast T8 to HPT8	94	4-Lamp F32T8 w/ Elec. Ballast	114	\$65	20
2-lamp High-Performance HPT8 Troffer or high efficiency retrofit troffer	49	3-Lamp F32T8 w/ Elec. Ballast	88	\$100	39

⁴²⁶ Adapted from Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011.

A- 3: RWT8 New and Baseline Assumptions

EE Measure Description	EE Cost	System WattsEE	Baseline Description	Base Cost	System Watts Base	Measure Cost	WattsSAVE
RWT8 - F28T8 Lamp	\$4.50	25	F32T8 Standard Lamp	\$2.50	28	\$2.00	4
RWT8 - F28T8 Extra Life Lamp	\$4.50	25	F32T8 Standard Lamp	\$2.50	28	\$2.00	4
RWT8 - F32/25W T8 Lamp	\$4.50	22	F32T8 Standard Lamp	\$2.50	28	\$2.00	6
RWT8 - F32/25W T8 Lamp Extra Life	\$4.50	22	F32T8 Standard Lamp	\$2.50	28	\$2.00	6
RWT8 - F17T8 Lamp - 2 Foot	\$4.80	14	F17T8 Standard Lamp - 2 foot	\$2.80	16	\$2.00	2
RWT8 - F25T8 Lamp - 3 Foot	\$5.10	20	F25T8 Standard Lamp - 3 foot	\$3.10	23	\$2.00	3
RWT8 - F30T8 Lamp - 6" Utube	\$11.31	26	F32T8 Standard Utube Lamp	\$9.31	28	\$2.00	2
RWT8 - F29T8 Lamp - Utube	\$11.31	26	F32T8 Standard Utube Lamp	\$9.31	28	\$2.00	3
RWT8 - F96T8 Lamp - 8 Foot	\$9.00	57	F96T8 Standard Lamp - 8 foot	\$7.00	62	\$2.00	5

Notes: Wattage assumptions for Reduced-Wattage T8 based on Existing 0.88 Normal Ballast Factor.

B-1: Time of Sale T8 Component Costs and Lifetime⁴²⁷

EE Measure Description	EE Lamp Cost	EE Lamp Life (hrs)	EE Lamp Rep. Labor Cost per lamp	EE Ballast Cost	EE Ballast Life (hrs)	EE Ballast Rep. Labor Cost	Baseline Description	Base Lamp Cost	Base Lamp Life (hrs)	Base Lamp Rep. Labor Cost	Base Ballast Cost	Base Ballast Life (hrs)	Base Ballast Rep. Labor Cost
4-Lamp HPT8 w/ High-BF Ballast High-Bay	\$5.00	24000	\$6.67	\$32.50	70000	\$15.00	200 Watt Pulse Start Metal-Halide	\$21.00	10000	\$6.67	\$88	40000	\$22.50
6-Lamp HPT8 w/ High-BF Ballast High-Bay	\$5.00	24000	\$6.67	\$32.50	70000	\$15.00	320 Watt Pulse Start Metal-Halide	\$21.00	20000	\$6.67	\$109	40000	\$22.50
8-Lamp HPT8 w/ High-BF Ballast High-Bay	\$5.00	24000	\$6.67	\$32.50	70000	\$15.00	Lamp HPT8 Equivalent to 320 PSMH	\$21.00	20000	\$6.67	\$109	40000	\$22.50
1-Lamp HPT8 - all qualifying lamps	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	1-Lamp Standard F32T8 w/ Elec. Ballast	\$2.50	20000	\$2.67	\$15	70000	\$15.00
2-Lamp HPT8 - all qualifying lamps	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	2-Lamp Standard F32T8 w/ Elec. Ballast	\$2.50	20000	\$2.67	\$15	70000	\$15.00
3-Lamp HPT8 - all qualifying lamps	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	3-Lamp Standard F32T8 w/ Elec. Ballast	\$2.50	20000	\$2.67	\$15	70000	\$15.00
4-Lamp HPT8 - all qualifying lamps	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	4-Lamp Standard F32T8 w/ Elec. Ballast	\$2.50	20000	\$2.67	\$15	70000	\$15.00
2-lamp High-Performance HPT8 Troffer	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	3-Lamp F32T8 w/ Elec. Ballast	\$2.50	20000	\$2.67	\$15	70000	\$15.00

⁴²⁷ Ibid.

B-2: T8 Retrofit Component Costs and Lifetime⁴²⁸

EE Measure Description	EE Lamp Cost	EE Lamp Life (hrs)	EE Lamp Rep. Labor Cost per lamp	EE Ballast Cost	EE Ballast Life (hrs)	EE Ballast Rep. Labor Cost	Baseline Description	Base Lamp Cost	Base Lamp Life (hrs)	Base Lamp Rep. Labor Cost	Base Ballast Cost	Base Ballast Life (hrs)	Base Ballast Rep. Labor Cost
4-Lamp HPT8 w/ High-BF Ballast High-Bay	\$5.00	24000	\$6.67	\$32.50	70000	\$15.00	200 Watt Pulse Start Metal-Halide	\$29.00	12000	\$6.67	\$88	40000	\$22.50
							250 Watt Metal Halide	\$21.00	10000	\$6.67	\$92	40000	\$22.50
6-Lamp HPT8 w/ High-BF Ballast High-Bay	\$5.00	24000	\$6.67	\$32.50	70000	\$15.00	320 Watt Pulse Start Metal-Halide	\$72.00	20000	\$6.67	\$109	40000	\$22.50
							400 Watt Metal Halide	\$17.00	20000	\$6.67	\$114	40000	\$22.50
8-Lamp HPT8 w/ High-BF Ballast High-Bay	\$5.00	24000	\$6.67	\$32.50	70000	\$15.00	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	\$72.00	20000	\$6.67	\$109	40000	\$22.50
							Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 400 Watt Metal Halide	\$17.00	20000	\$6.67	\$114	40000	\$22.50
1-Lamp Relamp/Reballast T12 to HPT8 (all lamp/ballast combinations)	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	1-Lamp T12 all lamp/ballast combinations	\$2.70	20000	\$2.67	\$20	40000	\$15.00
2-Lamp Relamp/Reballast T12 to HPT8 (all lamp/ballast combinations)	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	2-Lamp T12 all lamp/ballast combinations	\$2.70	20000	\$2.67	\$20	40000	\$15.00
3-Lamp Relamp/Reballast T12 to HPT8 (all lamp/ballast combinations)	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	3-Lamp T12 all lamp/ballast combinations	\$2.70	20000	\$2.67	\$20	40000	\$15.00
4-Lamp Relamp/Reballast T12 to HPT8 (all lamp/ballast combinations)	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	4-Lamp T12 all lamp/ballast combinations	\$2.70	20000	\$2.67	\$20	40000	\$15.00
1-Lamp Relamp/Reballast T8 to HPT8	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	1-Lamp F32T8 w/ Elec. Ballast	\$2.70	20000	\$2.67	\$20	70000	\$15.00
2-Lamp Relamp/Reballast T8 to HPT8	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	2-Lamp F32T8 w/ Elec. Ballast	\$2.70	20000	\$2.67	\$20	70000	\$15.00
3-Lamp Relamp/Reballast T8 to HPT8	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	3-Lamp F32T8 w/ Elec. Ballast	\$2.70	20000	\$2.67	\$20	70000	\$15.00
4-Lamp Relamp/Reballast T8 to HPT8	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	4-Lamp F32T8 w/ Elec. Ballast	\$2.70	20000	\$2.67	\$20	70000	\$15.00
2-lamp High-Performance HPT8 Troffer or high efficiency retrofit reflective troffer	\$5.00	24000	\$2.67	\$32.50	70000	\$15.00	3-Lamp F32T8 w/ Elec. Ballast	\$2.50	20000	\$2.67	\$15	70000	\$15.00

B-3: Reduced Wattage T8 Component Costs and Lifetime⁴²⁹

⁴²⁸ Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, January 2012.

⁴²⁹ Adapted from EVT Technical Resource Manual, 2012-75, page 85.

EE Measure Description	EE Lamp Cost	EE Lamp Life (hrs)	Baseline Description	Base Lamp Cost	Base Lamp Life (hrs)	Base Lamp Rep. Labor Cost
RWT8 - F28T8 Lamp	\$4.50	30000	F32T8 Standard Lamp	\$2.50	15000	\$2.67
RWT8 - F28T8 Extra Life Lamp	\$4.50	36000	F32T8 Standard Lamp	\$2.50	15000	\$2.67
RWT8 - F32/25W T8 Lamp	\$4.50	30000	F32T8 Standard Lamp	\$2.50	15000	\$2.67
RWT8 - F32/25W T8 Lamp Extra Life	\$4.50	36000	F32T8 Standard Lamp	\$2.50	15000	\$2.67
RWT8 - F17T8 Lamp - 2 Foot	\$4.80	18000	F17T8 Standard Lamp - 2 foot	\$2.80	15000	\$2.67
RWT8 - F25T8 Lamp - 3 Foot	\$5.10	18000	F25T8 Standard Lamp - 3 foot	\$3.10	15000	\$2.67
RWT8 - F30T8 Lamp - 6" Utube	\$11.31	24000	F32T8 Standard Utube Lamp	\$9.31	15000	\$2.67
RWT8 - F29T8 Lamp - Utube	\$11.31	24000	F32T8 Standard Utube Lamp	\$9.31	15000	\$2.67
RWT8 - F96T8 Lamp - 8 Foot	\$9.00	24000	F96T8 Standard Lamp - 8 foot	\$7.00	15000	\$2.67

C-1: T12 Baseline Adjustment:

For measures installed in 2012 through 2015, the full savings (as calculated above in the Algorithm section) will be claimed through 2015. A savings adjustment will be applied to the annual savings for the remainder of the measure life. The adjustment to be applied for each measure is listed in the reference table below.

Savings Adjustment Factors

EE Measure Description	Savings Adjustment T12 EEmag ballast and 34 w lamps to HPT8	Savings Adjustment T12 EEmag ballast and 40 w lamps to HPT8	Savings Adjustment T12 mag ballast and 40 w lamps to HPT8
1-Lamp Relamp/Reballast T12 to HPT8	47%	30%	20%
2-Lamp Relamp/Reballast T12 to HPT8	53%	30%	22%
3-Lamp Relamp/Reballast T12 to HPT8	42%	38%	21%
4-Lamp Relamp/Reballast T12 to HPT8	44%	29%	23%

Measures installed in 2012 will claim full savings for four years, 2013 for three years, 2014 two years and 2015 one year. Savings adjustment factors will be applied to the full savings for savings starting in 2016 and for the remainder of the measure life. The savings adjustment is equal to the ratio between wattage reduction from T8 baseline to HPT8 and wattage reduction from T12 EE ballast with 40 w lamp baseline from the table 'T8 New and Baseline Assumptions'.⁴³⁰

Example: 2 lamp T8 to 2 lamp HPT8 retrofit saves 10 watts, while the T12 EE with 40 w lamp to HPT8 saves 33 watts. Thus the ratio of wattage reduced is 30%. Thus the ratio of wattage reduced is 30%.

MEASURE CODE: CI-LTG-T8FX-V02-140601

⁴³⁰ Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011

EPE Program Downloads. Web accessed <http://www.electricefficiency.com/downloads.asp?section=ci> download Copy of LSF_2012_v4.04_250rows.xls.

Kuiken et al, Focus on Energy Evaluation. Business Programs: Deemed Savings Manual v1.0, Kema, march 22, 2010 available at

http://www.focusonenergy.com/files/Document_Management_System/Evaluation/bpdeemedsavingsmanuav10_evaluationreport.pdf Based on ComEd's BILD program data from PY4 and PY5. For Residential installations, hours of use assumptions from '5.5.6 LED Downlights' should be used for LED fixtures and '5.5.8 LED Screw Based Omnidirectional Bulbs' should be used for LED bulbs.

4.5.4 LED Bulbs and Fixtures

DESCRIPTION

This characterization provides savings assumptions for a variety of LED lamps including Omnidirectional (e.g. A-Type lamps), Decorative (e.g. Globes and Torpedoes) and Directional (PAR Lamps, Reflectors, MR16), and fixtures including refrigerated case, recessed and outdoor/garage fixtures.

If the implementation strategy does not allow for the installation location to be known, a deemed split of 83% Commercial and 17% Residential should be used⁴³¹.

This measure was developed to be applicable to the following program types: TOS, NC, RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, new lamps must be Energy Star labeled. Lamps and fixtures should be found in the reference tables below. Fixtures must be Energy Star labeled or on the Design Lights Consortium qualifying fixture list.

DEFINITION OF BASELINE EQUIPMENT

Refer to the baseline tables. In 2012, Federal legislation stemming from the Energy Independence and Security Act of 2007 (EIAS) required all general-purpose light bulbs between 40 watts and 100 watts to have ~30% increased efficiency, essentially phasing out standard incandescent technology. In 2012, the 100 w lamp standards apply; in 2013 the 75 w lamp standards will apply, followed by restrictions on the 60 w and 40 w lamps in 2014.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

Lifetime is the life of the product, at the reported operating hours (lamp life in hours divided by operating hours per year – see reference table "LED component Costs and Lifetime." The analysis period is the same as the lifetime, capped at 15 years. (15 years from GDS Measure Life Report, June 2007).

DEEMED MEASURE COST

Wherever possible, actual incremental costs should be used. Refer to reference table "LED component Cost & Lifetime" for defaults.

LOADSHAPE

Loadshape C06 - Commercial Indoor Lighting

Loadshape C07 - Grocery/Conv. Store Indoor Lighting

⁴³¹ Based on ComEd's BILD program data from PY4 and PY5. For Residential installations, hours of use assumptions from '5.5.6 LED Downlights' should be used for LED fixtures and '5.5.8 LED Screw Based Omnidirectional Bulbs' should be used for LED bulbs.

- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in the reference section below.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ((Watts_{base} - Watts_{EE}) / 1000) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$ = Input wattage of the existing system. Reference the “LED New and Baseline Assumptions” table for default values.

$Watts_{EE}$ = New Input wattage of EE fixture. See the “LED New and Baseline Assumptions” table. For ENERGY STAR rated lamps the following lumen equivalence tables should be used:

Minimum Lumens	Maximum Lumens	Lumens used to calculate LED Wattage (midpoint)	LED Wattage ⁴³² (WattsEE)	Baseline 2014-2019 (WattsBase)	Delta Watts 2014-2019 (WattsEE)	Baseline Post EISA 2020 requirement ⁴³³ (WattsBase)	Delta Watts Post 2020 (WattsEE)
5280	6209	5745	104.4	300.0	195.6	300.0	195.6
3000	5279	4140	75.3	200.0	124.7	200.0	124.7
2601	2999	2800	50.9	150.0	99.1	150.0	99.1
1490	2600	2045	37.2	72.0	34.8	45.4	8.3
1050	1489	1270	23.1	53.0	29.9	28.2	5.1
750	1049	900	16.4	43.0	26.6	20.0	3.6
310	749	530	9.6	29.0	19.4	11.8	2.1
250	309	280	5.6	25.0	19.4	25.0	19.4

Minimum Lumens	Maximum Lumens	Lumens used to calculate LED Wattage (midpoint)	LED Wattage ⁴³⁴ (WattsEE)	Baseline 2014-2019 (WattsBase)	Delta Watts 2014-2019 (WattsEE)	Baseline Post EISA 2020 requirement ⁴³⁵ (WattsBase)	Delta Watts Post 2020 (WattsEE)
5280	6209	5745	104.4	300.0	195.6	300.0	195.6
3000	5279	4140	75.3	200.0	124.7	200.0	124.7
2601	2999	2800	50.9	150.0	99.1	150.0	99.1
1490	2600	2045	37.2	72.0	34.8	45.4	8.3
1050	1489	1270	23.1	53.0	29.9	28.2	5.1
750	1049	900	16.4	43.0	26.6	20.0	3.6
310	749	530	9.6	29.0	19.4	11.8	2.1
250	309	280	5.6	25.0	19.4	25.0	19.4

Decorative Lamps - ENERGY STAR Minimum Luminous Efficacy = 40lm/W for all lamps

⁴³² Based on ENERGY STAR specs – minimum luminous efficacy for Omnidirectional Lamps. For LED lamp power <10W = 50lm/W and for LED lamp power >=10W = 55lm/W.

⁴³³ Calculated as 45lm/W for all EISA non-exempt bulbs.

⁴³⁴ Based on ENERGY STAR specs – minimum luminous efficacy for Omnidirectional Lamps. For LED lamp power <10W = 50lm/W and for LED lamp power >=10W = 55lm/W.

⁴³⁵ Calculated as 45lm/W for all EISA non-exempt bulbs.

Nominal wattage of lamp to be replaced (Watts _{base})	Minimum initial light output of LED lamp (lumens)	LED Wattage (Watts _{EE})	Delta Watts
10	70	1.75	8.25
15	90	2.25	12.75
25	150	3.75	21.25
40	300	7.5	32.5
60	500	12.5	47.5

Decorative lamps are exempt from EISA regulations.

Directional Lamps - ENERGY STAR Minimum Luminous Efficacy = 40lm/W for lamp diameter <= 20/8 inch (PAR 20 and smaller) and 45 Lm/W for lamp diameter > 20/8 inch (greater than PAR20).

Bulb Type	Lower Lumen Range	Upper Lumen Range	Lumens used to calculate LED Wattage (midpoint)	LED Wattage (Watts _{EE})	WattsBase	Delta Watts
Reflector with medium screw bases w/ diameter <=2.25"	400	449	425	10.6	40	29.4
	450	499	475	11.9	45	33.1
	500	649	575	14.4	50	35.6
	650	1199	925	23.1	65	41.9
R, PAR, ER, BR, BPAR or similar bulb shapes with medium screw bases w/ diameter >2.5" (*see exceptions below)	640	739	690	15.3	40	24.7
	740	849	795	17.7	45	27.3
	850	1179	1015	22.5	50	27.5
	1180	1419	1300	28.9	65	36.1
	1420	1789	1605	35.7	75	39.3
	1790	2049	1920	42.7	90	47.3
	2050	2579	2315	51.4	100	48.6
	2580	3429	3005	66.8	120	53.2
R, PAR, ER, BR, BPAR or similar bulb shapes with medium screw bases w/ diameter > 2.26" and ≤ 2.5" (*see exceptions	3430	4270	3850	85.6	150	64.4
	540	629	585	14.6	40	25.4
	630	719	675	16.9	45	28.1
	720	999	860	21.5	50	28.5
	1000	1199	1100	27.5	65	37.5
	1200	1519	1360	34.0	75	41.0
	1520	1729	1625	40.6	90	49.4

Bulb Type	Lower Lumen Range	Upper Lumen Range	Lumens used to calculate LED Wattage (midpoint)	LED Wattage (Watts _{EE})	WattsBase	Delta Watts
below)	1730	2189	1960	49.0	100	51.0
	2190	2899	2545	63.6	120	56.4
	2900	3850	3375	84.4	150	65.6
*ER30, BR30, BR40, or ER40	400	449	425	10.6	40	29.4
	450	499	475	11.9	45	33.1
	500	649	575	14.4	50	35.6
*BR30, BR40, or ER40	650	1419	1035	23.0	65	42.0
*R20	400	449	425	10.6	40	29.4
	450	719	585	14.6	45	30.4
*All reflector lamps below lumen ranges specified above	200	299	250	6.2	20	13.8
	300	399	350	8.7	30	21.3

Directional lamps are exempt from EISA regulations.

Hours = Average hours of use per year are provided in the Reference Table in Section 4.5, Screw based bulb annual operating hours, for each building type. If unknown, use the Miscellaneous value.

WHFe = Waste heat factor for energy to account for cooling energy savings from efficient lighting are provided below for each building type in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

ISR = In service Rate -the percentage of units rebated that actually get installed.
= 91%⁴³⁶

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{437} = ((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the

⁴³⁶ Based on ComEd’s BILD program data from PY5.

⁴³⁷ Negative value because this is an increase in heating consumption due to the efficient lighting.

increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in a heat pump heated office in 2014 and sign off form provided:

$$\Delta kWh_{\text{heatpenalty}} = ((29-9/1000)*1.0*3088* -0.151$$

$$= - 9.3 \text{ kWh}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = ((\text{Watts}_{\text{base}}-\text{Watts}_{\text{EE}})/1000) * \text{ISR} * \text{WHF}_d * \text{CF}$$

Where:

WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is provided in Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

CF = Summer Peak Coincidence Factor for measure is provided in the Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in an office in 2014 and sign off form provided:

$$\Delta kW = ((29-9/1000)* 1.0*1.3*0.66$$

$$= 0.002 \text{ kW}$$

NATURAL GAS ENERGY SAVINGS

Heating Penalty if fossil fuel heated building (or if heating fuel is unknown):

$$\Delta \text{Therms} = (((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Referecne Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in an office in 2014 and sign off form provided:

$$\Delta\text{Therms} = ((29-9/1000)*1.0*3088* -0.016$$

$$= - 0.99 \text{ therms}$$

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

For all measures except Standard Omnidirectional lamps (which have an EISA baseline shift) the individual component lifetimes and costs are provided in the reference table section below⁴³⁸.

In order to account for the falling EISA Qualified bulb replacement cost provided above, an equivalent annual levelized baseline replacement cost over the lifetime of the LED bulb (assumed to be 25,000/4576 =5.5 years) is calculated (see "C&I OmniDirectional LED O&M Calc.xls"). The key assumptions used in this calculation are documented below⁴³⁹:

	Std Inc.	EISA Compliant Halogen	CFL
2014	\$0.34	\$1.25	N/A
2015	\$0.34	\$0.90	N/A
2016	\$0.34	\$0.80	N/A
2017	\$0.34	\$0.70	N/A
2018	\$0.34	\$0.60	N/A
2019	\$0.34	\$0.60	N/A
2020 & after	\$0.34	N/A	\$2.50

⁴³⁸ See "LED reference tables.xls" for breakdown of component cost assumptions.

⁴³⁹ Based upon pricing forecast developed by Applied Proactive Technologies Inc (APT) based on industry input and provided to Ameren.

The NPV for replacement lamps and annual levelized replacement costs using the statewide real discount rate of 5.23% are presented below:

Location	Lumen Level	NPV of replacement costs for period			Levelized annual replacement cost savings		
		June 2014 - May 2015	June 2015 - May 2016	June 2016 - May 2017	June 2014 - May 2015	June 2015 - May 2016	June 2016 - May 2017
Commercial	Lumens <310 or >2600 (EISA exempt)	\$6.94	\$6.94	\$6.94	\$1.49	\$1.49	\$1.49
	Lumens ≥ 310 and ≤ 2600 (EISA compliant)	\$16.86	\$13.90	\$11.51	\$3.63	\$2.99	\$2.48

For halogen bulbs, we assume the same replacement cycle as incandescent bulbs.⁴⁴⁰ The replacement cycle is based on the miscellaneous hours of use. Both incandescent and halogen lamps are assumed to last for 1,000 hours before needing replacement and CFLs after 10,000 hours.

⁴⁴⁰ The manufacturers of the new minimally compliant EISA Halogens are using regular incandescent lamps with halogen fill gas rather than halogen infrared to meet the standard and so the component rated life is equal to the standard incandescent.

LED New and Baseline Assumptions⁴⁴¹

LED Measure Description	WattsEE	Baseline Description	WattsBASE	Basis for Watt Assumptions	LED Lamp Cost	Baseline Cost (EISA 2012-2014, EISA 2020)	Incremental Cost (EISA 2012-2014, EISA 2020)	LED Minimum Lamp Life (hrs)
LED Screw and Pin-based Bulbs, Omnidirectional, < 10W	See tables above				\$30.00	\$0.34 (\$1.25, \$2.50)	\$29.66 (\$28.75, \$27.50)	25,000
LED Screw and Pin-based Bulbs, Omnidirectional, >= 10W					\$40.00	\$0.34 (\$1.25, \$2.50)	\$39.66 (\$38.75, \$37.50)	25,000
LED Screw and Pin-based Bulbs, Decorative					\$30.00	\$1.00	\$29.00	25,000
LED Screw-based Bulbs, Directional, < 15W					\$45.00	\$5.00	\$40.00	35,000
LED Screw-based Bulbs, Directional, >= 15W					\$55.00	\$5.00	\$50.00	35,000
LED Recessed, Surface, Pendant Downlights	17.6	Baseline LED Recessed, Surface, Pendant Downlights	54.3	2008-2010 EVT Historical Data of 947 Measures	50,000		\$50.00	
LED Track Lighting	12.2	Baseline LED Track Lighting	60.4	2008-2010 EVT Historical Data of 242 Measures	50,000		\$100.00	

⁴⁴¹ Data is based on Efficiency Vermont derived cost and actual installed wattage information.

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LED Wall-Wash Fixtures	8.3	Baseline LED Wall-Wash Fixtures	17.7	2008-2010 EVT Historical Data of 220 Measures	50,000		\$80.00	
LED Portable Desk/Task Light Fixtures	7.1	Baseline LED Portable Desk/Task Light Fixtures	36.2	2008-2010 EVT Historical Data of 21 Measures	50,000		\$50.00	
LED Undercabinet Shelf-Mounted Task Light Fixtures (per foot)	7.1	Baseline LED Undercabinet Shelf-Mounted Task Light Fixtures	36.2	2008-2010 EVT Historical Data of 21 Measures	50,000		\$25.00	
LED Refrigerated Case Light, Horizontal or Vertical (per foot of light bar)	7.6	Baseline LED Refrigerated Case Light, Horizontal or Vertical (per foot of light bar)	15.2	PG&E Refrigerated Case Study ⁴⁴² normalized to per foot of light bar.	50,000		\$50.00	
LED Freezer Case Light, Horizontal or Vertical (per foot)	7.7	Baseline LED Freezer Case Light, Horizontal or Vertical (per foot)	18.7	PG&E Refrigerated Case Study normalized to per foot.	50,000		\$50.00	
LED Display Case Light Fixture (per foot)	7.1	Baseline LED Display Case Light Fixture	36.2	Modeled after LED Undercabinet Shelf-Mounted Task Light Fixtures (per foot)	35,000		\$25.00	
LED 2x2 Recessed Light Fixture	44.9	T8 U-Tube 2L-FB32 w/ Elec - 2'	61.0	Based on average watts of DLC qualified products as of 11/21/11	35,000		\$75.00	
LED 2x4 Recessed Light Fixture	53.6	T8 3L-F32 w/ Elec - 4'	88.0	Based on average watts of DLC qualified products as of 11/21/11	35,000		\$125.00	

⁴⁴² LED Refrigeration Case Ltg Workpaper 053007 rev1, May 30, 2007

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LED 1x4 Recessed Light Fixture	32.2	T8 2L-F32 w/ Elec - 4'	59.0	Based on average watts of DLC qualified products as of 11/21/11	35,000		\$100.00	
LED High- and Low-Bay Fixtures	160.2	MH 250 W CWA Pulse Start	295.0	Based on average watts of DLC qualified products as of 11/21/11	35,000		\$200.00	
LED Outdoor Pole/Arm Mounted Parking/Roadway, < 30W	18.6	Baseline LED Outdoor Pole/Arm Mounted Parking/Roadway, < 30W	124.3	2008-2010 EVT Historical Data of 2,813 Measures	50,000		\$125.00	
LED Outdoor Pole/Arm Mounted Parking/Roadway, 30W - 75W	52.5	Baseline LED Outdoor Pole/Arm Mounted Parking/Roadway, 30W - 75W	182.9	2008-2010 EVT Historical Data of 1,081 Measures	50,000		\$250.00	
LED Outdoor Pole/Arm Mounted Parking/Roadway, >= 75W	116.8	Baseline LED Outdoor Pole/Arm Mounted Parking/Roadway, >= 75W	361.4	2008-2010 EVT Historical Data of 806 Measures	50,000		\$375.00	
LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, < 30W	18.6	Baseline LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, < 30W	124.3	2008-2010 EVT Historical Data of 2,813 Measures	50,000		\$125.00	
LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, 30W - 75W	52.5	Baseline LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, 30W - 75W	182.9	2008-2010 EVT Historical Data of 1,081 Measures	50,000		\$250.00	
LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, >= 75W	116.8	Baseline LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, >= 75W	361.4	2008-2010 EVT Historical Data of 806 Measures	50,000		\$375.00	

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LED Parking Garage/Canopy, < 30W	18.6	Baseline LED Parking Garage/Canopy, < 30W	124.3	2008-2010 EVT Historical Data of 2,813 Measures	50,000		\$125.00	
LED Parking Garage/Canopy, 30W - 75W	52.5	Baseline LED Parking Garage/Canopy, 30W - 75W	182.9	2008-2010 EVT Historical Data of 1,081 Measures	50,000		\$250.00	
LED Parking Garage/Canopy, >= 75W	116.8	Baseline LED Parking Garage/Canopy, >= 75W	361.4	2008-2010 EVT Historical Data of 806 Measures	50,000		\$375.00	
LED Wall-Mounted Area Lights, < 30W	18.6	Baseline LED Wall-Mounted Area Lights, < 30W	124.3	2008-2010 EVT Historical Data of 2,813 Measures	50,000		\$125.00	
LED Wall-Mounted Area Lights, 30W - 75W	52.5	Baseline LED Wall-Mounted Area Lights, 30W - 75W	182.9	2008-2010 EVT Historical Data of 1,081 Measures	50,000		\$250.00	
LED Wall-Mounted Area Lights, >= 75W	116.8	Baseline LED Wall-Mounted Area Lights, >= 75W	361.4	2008-2010 EVT Historical Data of 806 Measures	50,000		\$375.00	
LED Bollard, < 30W	13.9	Baseline LED Bollard, < 30W	54.3	2008-2010 EVT Historical Data of 33 Measures	50,000		\$150.00	
LED Bollard, >= 30W	41.0	Baseline LED Bollard, >= 30W	78.0	2008-2010 EVT Historical Data of 15 Measures	50,000		\$250.00	
LED Flood Light, < 15W	8.7	Baseline LED Flood Light, < 15W	51.7	Consistent with LED Screw-base Directional	50,000		\$35.00	

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LED Flood Light, >= 15W	16.2	Baseline LED Flood Light, >= 15W	64.4	Consistent with LED Screw-base Directional	50,000		\$45.00	
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LED Component Costs & Lifetime⁴⁴³

LED Component Costs and Lifetimes												
LED Measure Description	LED Minimum Lamp Life (hrs)	LED Lamp Cost Total	LED Driver Life (hrs)	LED Driver Cost Total	Baseline Technology (1)	Lamp (1) Life (hrs)	Lamp (1) Total Cost	Ballast (1) Life (hrs)	Ballast (1) Total Cost	Baseline Technology (2)	Lamp (2) Life (hrs)	Lamp (2) Total Cost
LED Screw and Pin-based Bulbs, Decorative	25,000	N/A	N/A	N/A	53W EISA Halogen	2,000	\$4.67	N/A	N/A	N/A	N/A	N/A
LED Screw-based Bulbs, Directional, < 15W	35,000	N/A	N/A	N/A	15% CFL 18W Pin Base	10,000	\$11.62	40,000	\$36.00	85% Halogen PAR20	2,500	\$12.67
LED Screw-based Bulbs, Directional, >= 15W	35,000	N/A	N/A	N/A	15% CFL 26W Pin Base	10,000	\$12.62	40,000	\$36.00	85% Halogen PAR30/38	2,500	\$12.67
LED Recessed, Surface, Pendant Downlights	50,000	\$47.50	70,000	\$47.50	40% CFL 26W Pin Base	10,000	\$12.62	40,000	\$36.00	60% Halogen PAR30/38	2,500	\$12.67
LED Track Lighting	50,000	\$47.50	70,000	\$47.50	10% PAR38 CMH	12,000	\$62.92	40,000	\$110.00	90% Halogen PAR38	2,500	\$12.67

⁴⁴³ Note some measures have blended baselines. All values are provided to enable calculation of appropriate O&M impacts. Total costs include lamp, labor and disposal cost assumptions where applicable, see "LED reference tables.xls" for more information.

Illinois Statewide Technical Reference Manual - 4.5.4 LED Bulbs and Fixtures

LED Wall-Wash Fixtures	50,000	\$47.50	70,000	\$47.50	40% CFL 42W Pin Base	10,000	\$15.72	40,000	\$67.50	60% Halogen PAR38	2,500	\$12.67
LED Portable Desk/Task Light Fixtures	50,000	\$47.50	70,000	\$47.50	50% 13W CFL Pin Base	10,000	\$5.52	40,000	\$25.00	50% 50W Halogen	2,500	\$12.67
LED Undercabinet Shelf- Mounted Task Light Fixtures (per foot)	50,000	\$47.50	70,000	\$47.50	50% 2' T5 Linear	7,500	\$9.92	40,000	\$45.00	50% 50W Halogen	2,500	\$12.67
LED Refrigerated Case Light, Horizontal or Vertical (per foot)	50,000	\$9.50	70,000	\$9.50	5' T8	15,000	\$2.77	40,000	\$9.50	N/A	N/A	N/A
LED Freezer Case Light, Horizontal or Vertical (per foot)	50,000	\$8.75	70,000	\$7.92	6' T12HO	12,000	\$11.03	40,000	\$59.58	N/A	N/A	N/A
LED Display Case Light Fixture (per foot)	35,000	\$47.50	70,000	\$28.75	50% 2' T5 Linear	7,500	\$9.92	40,000	\$45.00	50% 50W Halogen	2,500	\$12.67
LED 2x2 Recessed Light Fixture	35,000	\$47.50	70,000	\$47.50	T8 U-Tube 2L- FB32 w/ Elec - 2'	15,000	\$24.95	40,000	\$52.00	N/A	N/A	N/A
LED 2x4 Recessed Light Fixture	35,000	\$72.50	70,000	\$47.50	T8 3L-F32 w/ Elec - 4'	15,000	\$17.00	40,000	\$35.00	N/A	N/A	N/A
LED 1x4 Recessed Light Fixture	35,000	\$47.50	70,000	\$47.50	T8 2L-F32 w/ Elec - 4'	15,000	\$11.33	40,000	\$35.00	N/A	N/A	N/A
LED High- and Low-Bay Fixtures	35,000	\$112.50	70,000	\$62.50	250W MH	10,000	\$41.25	40,000	\$130.25	N/A	N/A	N/A
LED Outdoor Pole/Arm Mounted	50,000	\$62.50	70,000	\$62.50	100W MH	10,000	\$54.25	40,000	\$166.70	N/A	N/A	N/A

Illinois Statewide Technical Reference Manual - 4.5.4 LED Bulbs and Fixtures

Parking/Roadway, < 30W												
LED Outdoor Pole/Arm Mounted Parking/Roadway, 30W - 75W	50,000	\$87.50	70,000	\$62.50	175W MH	10,000	\$48.25	40,000	\$110.00	N/A	N/A	N/A
LED Outdoor Pole/Arm Mounted Parking/Roadway, >= 75W	50,000	\$112.50	70,000	\$62.50	250W MH	10,000	\$41.25	40,000	\$130.25	N/A	N/A	N/A
LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, < 30W	50,000	\$62.50	70,000	\$62.50	100W MH	10,000	\$54.25	40,000	\$166.70	N/A	N/A	N/A
LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, 30W - 75W	50,000	\$87.50	70,000	\$62.50	175W MH	10,000	\$48.25	40,000	\$110.00	N/A	N/A	N/A
LED Outdoor Pole/Arm Mounted Decorative Parking/Roadway, >= 75W	50,000	\$112.50	70,000	\$62.50	250W MH	10,000	\$41.25	40,000	\$130.25	N/A	N/A	N/A
LED Parking Garage/Canopy, < 30W	50,000	\$47.50	70,000	\$47.50	100W MH	10,000	\$36.92	40,000	\$151.70	N/A	N/A	N/A
LED Parking Garage/Canopy, 30W - 75W	50,000	\$72.50	70,000	\$47.50	175W MH	10,000	\$30.92	40,000	\$95.00	N/A	N/A	N/A
LED Parking Garage/Canopy, >= 75W	50,000	\$97.50	70,000	\$47.50	250W MH	10,000	\$23.92	40,000	\$115.25	N/A	N/A	N/A
LED Wall-Mounted Area	50,000	\$47.50	70,000	\$47.50	100W MH	10,000	\$36.92	40,000	\$151.70	N/A	N/A	N/A

Illinois Statewide Technical Reference Manual - 4.5.4 LED Bulbs and Fixtures

Lights, < 30W												
LED Wall-Mounted Area Lights, 30W - 75W	50,000	\$72.50	70,000	\$47.50	175W MH	10,000	\$30.92	40,000	\$95.00	N/A	N/A	N/A
LED Wall-Mounted Area Lights, >= 75W	50,000	\$97.50	70,000	\$47.50	250W MH	10,000	\$23.92	40,000	\$115.25	N/A	N/A	N/A
LED Bollard, < 30W	50,000	\$47.50	70,000	\$47.50	50W MH	10,000	\$36.92	40,000	\$135.50	N/A	N/A	N/A
LED Bollard, >= 30W	50,000	\$72.50	70,000	\$47.50	70W MH	10,000	\$36.92	40,000	\$142.50	N/A	N/A	N/A
LED Flood Light, < 15W	50,000	\$47.50	70,000	\$47.50	25% 50W MH	10,000	\$36.92	40,000	\$135.50	75% Halogen PAR20	2,500	\$12.67
LED Flood Light, >= 15W	50,000	\$47.50	70,000	\$47.50	50% 50W MH	10,000	\$36.92	40,000	\$135.50	50% Halogen PAR30/38	2,500	\$12.67

MEASURE CODE: CI-LTG-LEDB-V02-140601

4.5.5 Commercial LED Exit Signs

DESCRIPTION

This measure characterizes the savings associated with installing a Light Emitting Diode (LED) exit sign in place of a fluorescent or incandescent exit sign in a Commercial building. Light Emitting Diode exit signs have a string of very small, typically red or green, glowing LEDs arranged in a circle or oval. The LEDs may also be arranged in a line on the side, top or bottom of the exit sign. LED exit signs provide the best balance of safety, low maintenance, and very low energy usage compared to other exit sign technologies.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is assumed to be an exit sign illuminated by LEDs.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be a fluorescent or incandescent model.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The measure life is assumed to be 16 years⁴⁴⁴.

DEEMED MEASURE COST

The incremental cost for this measure is assumed to be \$30⁴⁴⁵.

LOADSHAPE

Loadshape C53 - Flat

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is assumed to be 100%⁴⁴⁶.

⁴⁴⁴ 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008.

⁴⁴⁵ NYSERDA Deemed Savings Database, Labor cost assumes 25 minutes @ \$18/hr.

⁴⁴⁶ Assuming continuous operation of an LED exit sign, the Summer Peak Coincidence Factor is assumed to equal 1.0.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ((WattsBase - WattsEE) / 1000) * HOURS * WHF_e$$

Where:

WattsBase = Actual wattage if known, if unknown assume the following:

Baseline Type	WattsBase
Incandescent	35W ⁴⁴⁷
Fluorescent	11W ⁴⁴⁸
Unknown (e.g. time of sale)	23W ⁴⁴⁹

WattsEE = Actual wattage if known, if unknown assume 2W⁴⁵⁰

HOURS = Annual operating hours
= 8766

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting are provided for each building type in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, replacing incandescent fixture in an office

$$\begin{aligned} \Delta kWh &= (35 - 2) / 1000 * 8766 * 1.25 \\ &= 362 \text{ kWh} \end{aligned}$$

For example, replacing fluorescent fixture in a hospital

$$\begin{aligned} \Delta kWh &= (11 - 2) / 1000 * 8766 * 1.35 \\ &= 106.5 \text{ kWh} \end{aligned}$$

⁴⁴⁷ Based on review of available product.

⁴⁴⁸ Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010

⁴⁴⁹ ComEd has been using a weighted baseline of 70 percent incandescent and 30 percent compact fluorescent, reflecting program experience and a limited sample of evaluation verification findings that we consider to be reasonable (Navigant, through comment period February 2013)

⁴⁵⁰ Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{451} = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{Hours} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, replacing incandescent fixture in a heat pump heated office

$$\Delta kWh_{\text{heatpenalty}} = (35 - 2) / 1000 * 8760 * -0.151$$

$$= -43.7 \text{ kWh}$$

For example, replacing fluorescent fixture in a heat pump heated hospital

$$\Delta kWh_{\text{heatpenalty}} = (11 - 2) / 1000 * 8760 * -0.104$$

$$= 8.2 \text{ kWh}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{WHF}_d * \text{CF}$$

Where:

WHF_d = Waste heat factor for demand to account for cooling savings from efficient lighting in cooled buildings is provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value..

CF = Summer Peak Coincidence Factor for measure
= 1.0

⁴⁵¹Negative value because this is an increase in heating consumption due to the efficient lighting.

For example, replacing incandescent fixture in an office

$$\Delta kW = (35 - 2)/1000 * 1.3 * 1.0$$

$$= 0.043 \text{ kW}$$

For example, replacing fluorescent fixture in a hospital

$$\Delta kW = (11 - 2)/1000 * 1.69 * 1.0$$

$$= 0.015 \text{ kW}$$

NATURAL GAS SAVINGS

Heating Penalty if natural gas heated building (or if heating fuel is unknown):

$$\Delta \text{therms} = (((\text{WattsBase} - \text{WattsEE})/1000) * \text{Hours} * \text{IFTherms})$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

For example, replacing incandescent fixture in an office

$$\Delta \text{Therms} = (35 - 2)/1000 * 8760 * -0.016$$

$$= -4.63 \text{ Therms}$$

For example, replacing fluorescent fixture in a hospital

$$\Delta \text{Therms} = (11 - 2)/1000 * 8760 * -0.011$$

$$= 0.87 \text{ Therms}$$

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

The annual O&M Cost Adjustment savings should be calculated using the following component costs and lifetimes.

Component	Baseline Measures	
	Cost	Life (yrs)

Lamp	\$7.00 ⁴⁵²	1.37 years ⁴⁵³
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MEASURE CODE: CI-LTG-LEDE-V02-140601

⁴⁵² Consistent with assumption for a Standard CFL bulb with an estimated labor cost of \$4.50 (assuming \$18/hour and a task time of 15 minutes).

⁴⁵³ Assumes a lamp life of 12,000 hours and 8766 run hours $12000/8766 = 1.37$ years.

4.5.6 LED Traffic and Pedestrian Signals

DESCRIPTION

Traffic and pedestrian signals are retrofitted to be illuminated with light emitting diodes (LED) instead of incandescent lamps. Incentive applies for the replacement or retrofit of existing incandescent traffic signals with new LED traffic and pedestrian signal lamps. Each lamp can have no more than a maximum LED module wattage of 25. Incentives are not available for spare lights. Lights must be hardwired and single lamp replacements are not eligible, with the exception of pedestrian hand signals. Eligible lamps must meet the Energy Star Traffic Signal Specification and the Institute for Transportation Engineers specification for traffic signals.

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

Refer to the Table titled 'Traffic Signals Technology Equivalencies' for efficient technology wattage and savings assumptions.

DEFINITION OF BASELINE EQUIPMENT

Refer to the Table titled 'Traffic Signals Technology Equivalencies' for baseline efficiencies and savings assumptions.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The assumed lifetime of an LED traffic signal is 100,000 hours (manufacturer's estimate), capped at 10 years.⁴⁵⁴ The life in years is calculated by dividing 100,000 hrs by the annual operating hours for the particular signal type.

DEEMED MEASURE COST

The actual measure installation cost should be used (including material and labor).

LOADSHAPE

Loadshape C24 - Traffic Signal - Red Balls, always changing or flashing

Loadshape C25 - Traffic Signal - Red Balls, changing day, off night

Loadshape C26 - Traffic Signal - Green Balls, always changing

Loadshape C27 - Traffic Signal - Green Balls, changing day, off night

Loadshape C28 - Traffic Signal - Red Arrows

Loadshape C29 - Traffic Signal - Green Arrows

Loadshape C30 - Traffic Signal - Flashing Yellows

Loadshape C31 - Traffic Signal - "Hand" Don't Walk Signal

⁴⁵⁴ ACEEE, (1998) A Market Transformation Opportunity Assessment for LED Traffic Signals, <http://www.cee1.org/gov/led/led-ace3/ace3led.pdf>

Loadshape C32 - Traffic Signal - “Man” Walk Signal

Loadshape C33 - Traffic Signal - Bi-Modal Walk/Don’t Walk

COINCIDENCE FACTOR⁴⁵⁵

The summer peak coincidence factor (CF) for this measure is dependent on lamp type as below:

Lamp Type	CF
Red Round, always changing or flashing	0.55
Red Arrows	0.90
Green Arrows	0.10
Yellow Arrows	0.03
Green Round, always changing or flashing	0.43
Flashing Yellow	0.50
Yellow Round, always changing	0.02
“Hand” Don’t Walk Signal	0.75
“Man” Walk Signal	0.21

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (W_{base} - W_{eff}) \times HOURS / 1000$$

Where:

Wbase =The connected load of the baseline equipment
 = see Table ‘Traffic Signals Technology Equivalencies’

Weff =The connected load of the baseline equipment
 = see Table ‘Traffic Signals Technology Equivalencies’

⁴⁵⁵ Ibid

EFLH = annual operating hours of the lamp
= see Table 'Traffic Signals Technology Equivalencies'

1000 = conversion factor (W/kW)

EXAMPLE

For example, an 8 inch red, round signal:

$$\begin{aligned}\Delta kWh &= ((69 - 7) \times 4818) / 1000 \\ &= 299 \text{ kWh}\end{aligned}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (W_{base} - W_{eff}) \times CF / 1000$$

Where:

W_{base} =The connected load of the baseline equipment
= see Table 'Traffic Signals Technology Equivalencies'

W_{eff} =The connected load of the efficient equipment
= see Table 'Traffic Signals Technology Equivalencies'

CF = Summer Peak Coincidence Factor for measure

EXAMPLE

For example, an 8 inch red, round signal:

$$\begin{aligned}\Delta kW &= ((69 - 7) \times 0.55) / 1000 \\ &= 0.0341 \text{ kW}\end{aligned}$$

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

REFERENCE TABLES

Traffic Signals Technology Equivalencies⁴⁵⁶

Traffic Fixture Type	Fixture and Color	Size	Efficient Lamps	Baseline Lamps	HOURS	Efficient Fixture Wattage	Baseline Fixture Wattage	Energy Savings (in kWh)
Round Signals	8" Red		LED	Incandescent	4818	7	69	299
Round Signals	12" Red		LED	Incandescent	4818	6	150	694
Flashing Signal ⁴⁵⁷	8" Red		LED	Incandescent	4380	7	69	272
Flashing Signal	12" Red		LED	Incandescent	4380	6	150	631
Flashing Signal	8" Yellow		LED	Incandescent	4380	10	69	258
Flashing Signal	12" Yellow		LED	Incandescent	4380	13	150	600
Round Signals	8" Yellow		LED	Incandescent	175	10	69	10
Round Signals	12" Yellow		LED	Incandescent	175	13	150	24
Round Signals	8" Green		LED	Incandescent	3767	9	69	266
Round Signals	12" Green		LED	Incandescent	3767	12	150	520
Turn Arrows	8" Yellow		LED	Incandescent	701	7	116	76
Turn Arrows	12" Yellow		LED	Incandescent	701	9	116	75

⁴⁵⁶ Technical Reference Manual for Pennsylvania Act 129 Energy Efficiency and Conservation Program and Act 213 Alternative Energy Portfolio Standards. Pennsylvania Public Utility Commission. May 2009

⁴⁵⁷ Technical Reference Manual for Ohio, August 6, 2010

ILLINOIS STATEWIDE TECHNICAL REFERENCE MANUAL - 4.5.6 LED TRAFFIC AND PEDESTRIAN SIGNALS

Traffic Fixture Type	Fixture Size and Color	Efficient Lamps	Baseline Lamps	HOURS	Efficient Fixture Wattage	Baseline Fixture Wattage	Energy Savings (in kWh)
Turn Arrows	8" Green	LED	Incandescent	701	7	116	76
Turn Arrows	12" Green	LED	Incandescent	701	7	116	76
Pedestrian Sign	12" Hand/Man	LED	Incandescent	8760	8	116	946

Reference specifications for above traffic signal wattages are from the following manufacturers:

1. 8" Incandescent traffic signal bulb: General Electric Traffic Signal Model 17325-69A21/TS
2. 12" Incandescent traffic signal bulb: General Electric Signal Model 35327-150PAR46/TS
3. Incandescent Arrows & Hand/Man Pedestrian Signs: General Electric Traffic Signal Model 19010-116A21/TS
4. 8" and 12" LED traffic signals: Leotek Models TSL-ES08 and TSL-ES12
5. 8" LED Yellow Arrow: General Electric Model DR4-YTA2-01A
6. 8" LED Green Arrow: General Electric Model DR4-GCA2-01A
7. 12" LED Yellow Arrow: Dialight Model 431-3334-001X
8. 12: LED Green Arrow: Dialight Model 432-2324-001X
9. LED Hand/Man Pedestrian Sign: Dialight 430-6450-001X

MEASURE CODE: CI-LTG-LEDT-V01-120601

4.5.7 Lighting Power Density

DESCRIPTION

This measure relates to installation of efficient lighting systems in new construction or substantial renovation of commercial buildings excluding low rise (three stories or less) residential buildings. Substantial renovation is when two or more building systems are renovated, such as shell and heating, heating and lighting, etc. State Energy Code specifies a lighting power density level by building type for both the interior and the exterior. Either the Building Area Method or Space by Space method as defined in IECC 2012 can be used for calculating the Interior Lighting Power Density⁴⁵⁸. The measure consists of a design that is more efficient (has a lower lighting power density in watts/square foot) than code requires. The IECC 2012, which is adopted in Illinois, applies to both new construction and renovation.

This measure was developed to be applicable to the following program types: NC.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the lighting system must be more efficient than the baseline Energy Code lighting power density in watts/square foot for either the interior space or exterior space.

DEFINITION OF BASELINE EQUIPMENT

The baseline is assumed to be a lighting power density that meets IECC 2012, the State of Illinois Energy Code requirements.

DEEMED CALCULATION FOR THIS MEASURE

$$\text{Annual kWh Savings} = \Delta\text{kWh} = (\text{WSF}_{\text{base}} - \text{WSF}_{\text{effic}}) / 1000 * \text{SF} * \text{Hours} * \text{WHF}_e$$

$$\text{Summer Coincident Peak kW Savings} = \Delta\text{kW} = (\text{WSF}_{\text{base}} - \text{WSF}_{\text{effic}}) / 1000 * \text{SF} * \text{CF} * \text{WHF}_d$$

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years⁴⁵⁹

DEEMED MEASURE COST

The actual incremental cost over a baseline system will be collected from the customer if possible or developed on a fixture by fixture basis.

⁴⁵⁸ Refer to the referenced code documents for specifics on calculating lighting power density using either the whole building method (IECC) or the Space by Space method (ASHRAE 90.1).

⁴⁵⁹ Measure Life Report, Residential and Commercial/Industrial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007.

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the building type.

Algorithm

CALCULATION OF SAVINGS

ENERGY SAVINGS

$$\Delta kWh = (WSF_{base} - WSF_{effic}) / 1000 * SF * Hours * WHF_e$$

Where:

WSF_{base} = Baseline lighting watts per square foot or linear foot as determined by building or space type. Whole building analysis values are presented in the Reference Tables below.⁴⁶⁰

WSF_{effic} = The actual installed lighting watts per square foot or linear foot.

SF = Provided by customer based on square footage of the building area applicable to the lighting design for new building.

Hours = Annual site-specific hours of operation of the lighting equipment collected from the customer. If not available, use building area type as provided in the Reference Table in Section 4.5, Fixture annual operating hours.

⁴⁶⁰ IECC 2012 - Reference Code documentation for additional information.

WHF_e = Waste Heat Factor for Energy to account for cooling savings from efficient lighting is as provided in the Reference Table in Section 4.5 by building type. If building is not cooled WHF_e is 1.

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{461} = (WSF_{\text{base}} - WSF_{\text{effic}}) / 1000 * SF * \text{Hours} * -IFkWh$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (WSF_{\text{base}} - WSF_{\text{effic}}) / 1000 * SF * CF * WHF_d$$

Where:

WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is as provided in the Reference Table in Section 4.5 by building type. If building is not cooled WHF_d is 1.

CF = Summer Peak Coincidence Factor for measure is as provided in the Reference Table in Section 4.5 by building type. If the building type is unknown, use the Miscellaneous value of 0.66.

Other factors as defined above

NATURAL GAS ENERGY SAVINGS

$$\Delta \text{Therms} = (WSF_{\text{base}} - WSF_{\text{effic}}) / 1000 * SF * \text{Hours} * -IF\text{Therms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. This value is provided in the Reference Table in Section 4.5 by building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

⁴⁶¹Negative value because this is an increase in heating consumption due to the efficient lighting.

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

REFERENCE TABLES

Lighting Power Density Values from IECC 2012 for Interior Commercial New Construction and Substantial Renovation Building Area Method:

Building Area Type ⁴⁶²	Lighting Power Density (w/ft ²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Fire station	0.8
Gymnasium	1.1
Healthcare – clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	0.9
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police Station	1.0
Post Office	1.1
Religious Building	1.3
Retail ⁴⁶³	1.4

⁴⁶² IECC 2012 in cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.

⁴⁶³ Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the small of the actual wattage of the lighting equipment installed specifically for merchandise, or additional lighting power as determined below shall be added to the interior lighting power determined in accordance with this line item.

Building Area Type ⁴⁶²	Lighting Power Density (w/ft ²)
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.6
Workshop	1.4

Lighting Power Density Values from IECC 2012 for Interior Commercial New Construction and Substantial Renovation Space by Space Method:

COMMERCIAL ENERGY EFFICIENCY

TABLE C405.5.2(2)
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

COMMON SPACE-BY-SPACE TYPES	LPD (w/ft ²)
Atrium – First 40 feet in height	0.03 per ft. ht.
Atrium – Above 40 feet in height	0.02 per ft. ht.
Audience/seating area – permanent	
For auditorium	0.9
For performing arts theater	2.6
For motion picture theater	1.2
Classroom/lecture/training	1.30
Conference/meeting/multipurpose	1.2
Corridor/transition	0.7
Dining area	
Bar/lounge/leisure dining	1.40
Family dining area	1.40
Dressing/fitting room performing arts theater	1.1
Electrical/mechanical	1.10
Food preparation	1.20
Laboratory for classrooms	1.3
Laboratory for medical/industrial/research	1.8
Lobby	1.10
Lobby for performing arts theater	3.3
Lobby for motion picture theater	1.0
Locker room	0.80
Lounge recreation	0.8
Office – enclosed	1.1
Office – open plan	1.0
Restroom	1.0
Sales area	1.6*
Stairway	0.70
Storage	0.8
Workshop	1.60
Courthouse/police station/penitentiary	
Courtroom	1.90
Confinement cells	1.1
Judge chambers	1.30
Penitentiary audience seating	0.5
Penitentiary classroom	1.3
Penitentiary dining	1.1
BUILDING SPECIFIC SPACE-BY-SPACE TYPES	
Automotive – service/repair	0.70
Bank/office – banking activity area	1.5
Dormitory living quarters	1.10
Gymnasium/fitness center	
Fitness area	0.9
Gymnasium audience/seating	0.40
Playing area	1.40

(continued)

TABLE C405.5.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD

COMMON SPACE-BY-SPACE TYPES	LPD (w/ft ²)
Healthcare clinic/hospital	
Corridors/transition	1.00
Exam/treatment	1.70
Emergency	2.70
Public and staff lounge	0.80
Medical supplies	1.40
Nursery	0.9
Nurse station	1.00
Physical therapy	0.90
Patient room	0.70
Pharmacy	1.20
Radiology/imaging	1.3
Operating room	2.20
Recovery	1.2
Lounge/recreation	0.8
Laundry – washing	0.60
Hotel	
Dining area	1.30
Guest rooms	1.10
Hotel lobby	2.10
Highway lodging dining	1.20
Highway lodging guest rooms	1.10
Library	
Stacks	1.70
Card file and cataloguing	1.10
Reading area	1.20
Manufacturing	
Corridors/transition	0.40
Detailed manufacturing	1.3
Equipment room	1.0
Extra high bay (> 50-foot floor-ceiling height)	1.1
High bay (25 – 50-foot floor-ceiling height)	1.20
Low bay (< 25-foot floor-ceiling height)	1.2
Museum	
General exhibition	1.00
Restoration	1.70
Parking garage – garage areas	0.2
Convention center	
Exhibit space	1.50
Audience/seating area	0.90
Fire stations	
Engine room	0.80
Sleeping quarters	0.30
Post office	
Sorting area	0.9
Religious building	
Fellowship hall	0.60
Audience seating	2.40
Worship pulpit/choir	2.40
Retail	
Dressing/fitting area	0.9
Mall concourse	1.6
Sales area	1.6*

(continued)

**TABLE C405.5.2(2)—continued
INTERIOR LIGHTING POWER ALLOWANCES:
SPACE-BY-SPACE METHOD**

BUILDING SPECIFIC SPACE-BY-SPACE TYPES	LPD (w/ft ²)
Sports arena	
Audience seating	0.4
Court sports area – Class 4	0.7
Court sports area – Class 3	1.2
Court sports area – Class 2	1.9
Court sports area – Class 1	3.0
Ring sports area	2.7
Transportation	
Air/train/bus baggage area	1.00
Airport concourse	0.60
Terminal – ticket counter	1.50
Warehouse	
Fine material storage	1.40
Medium/bulky material	0.60

The exterior lighting design will be based on the building location and the applicable “Lighting Zone” as defined in IECC 2012 Table C405.6.2(1) which follows.

**TABLE C405.6.2(1)
EXTERIOR LIGHTING ZONES**

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

The lighting power density savings will be based on reductions below the allowable design levels as specified in IECC 2012 Table 405.6.2(2) which follows.

ILLINOIS STATEWIDE TECHNICAL REFERENCE MANUAL - 4.5.7 LIGHTING POWER DENSITY

**TABLE C405.6.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

		LIGHTING ZONES			
		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance is usable in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W
Uncovered Parking Areas					
	Parking areas and drives	0.04 W/ft ²	0.06 W/ft ²	0.10 W/ft ²	0.13 W/ft ²
Building Grounds					
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas special feature areas	0.14 W/ft ²	0.14 W/ft ²	0.16 W/ft ²	0.2 W/ft ²
	Stairways	0.75 W/ft ²	1.0 W/ft ²	1.0 W/ft ²	1.0 W/ft ²
	Pedestrian tunnels	0.15 W/ft ²	0.15 W/ft ²	0.2 W/ft ²	0.3 W/ft ²
Building Entrances and Exits					
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft ²	0.25 W/ft ²	0.4 W/ft ²	0.4 W/ft ²
Sales Canopies					
	Free-standing and attached	0.6 W/ft ²	0.6 W/ft ²	0.8 W/ft ²	1.0 W/ft ²
Outdoor Sales					
	Open areas (including vehicle sales lots)	0.25 W/ft ²	0.25 W/ft ²	0.5 W/ft ²	0.7 W/ft ²
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.1 W/ft ² for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft ² for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft ² for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

MEASURE CODE: CI-LTG-LPDE-V02-1406

Miscellaneous Commercial/Industrial Lighting

4.5.8 Miscellaneous Commercial/Industrial Lighting

DESCRIPTION

This measure is designed to calculate savings from energy efficient lighting upgrades that are not captured in other measures within the TRM. If a lighting project fits the measure description in sections 4.5.1-4.5.4, then those criteria, definitions, and calculations should be used.

Unlike other lighting measures this one applies only to RF applications (because there is no defined baseline for TOS or NC applications).

DEFINITION OF EFFICIENT EQUIPMENT

A lighting fixture that replaces an existing fixture to provide the same or greater lumen output at a lower kW consumption.

DEFINITION OF BASELINE EQUIPMENT

The definition of baseline equipment is the existing lighting fixture.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed lifetime of the efficient equipment fixture, regardless of program type is 15 years⁴⁶⁴.

DEEMED MEASURE COST

The actual cost of the efficient light fixture should be used.

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)

⁴⁶⁴ 15 years from GDS Measure Life Report, June 2007

Miscellaneous Commercial/Industrial Lighting

Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)

Loadshape C18 - Industrial Indoor Lighting

Loadshape C19 - Industrial Outdoor Lighting

Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in section 4.5.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ((Watts_{base} - Watts_{EE}) / 1000) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$ = Input wattage of the existing system which depends on the baseline fixture configuration (number and type of lamp) and ballast factor (if applicable) and number of fixtures.

=Actual

$Watts_{EE}$ = New Input wattage of EE fixture which depends on new fixture configuration (number of lamps) and ballast factor (if applicable) (if applicable) and number of fixtures.

= Actual

Hours = Average hours of use per year as provided by the customer or selected from the Reference Table in Section 4.5, Fixture annual operating hours, by building type. If hours or building type are unknown, use the Miscellaneous value.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate or the percentage of units rebated that get installed.

=100%⁴⁶⁵ if application form completed with sign off that equipment is not

⁴⁶⁵ Illinois evaluation of PY1 through PY3 has not found that fixtures or lamps placed into storage to be a significant enough

Miscellaneous Commercial/Industrial Lighting

placed into storage

If sign off form not completed assume the following 3 year ISR assumptions:

Weighted Average 1 st year In Service Rate (ISR)	2 nd year Installations	3 rd year Installations	Final Lifetime In Service Rate
75.5% ⁴⁶⁶	12.1%	10.3%	98.0% ⁴⁶⁷

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{468} = (((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

DEFERRED INSTALLS

As presented above, if a sign off form is not completed the characterization assumes that a percentage of bulbs purchased are not installed until Year 2 and Year 3 (see ISR assumption above). The Illinois Technical Advisory Committee has determined the following methodology for calculating the savings of these future installs.

Year 1 (Purchase Year) installs: Characterized using assumptions provided above or evaluated assumptions if available.

Year 2 and 3 installs: Characterized using delta watts assumption and hours of use from the Install Year i.e. the actual deemed (or evaluated if available) assumptions active in Year 2 and 3 should be applied.

issue to warrant including an "In-Service Rate" when commercial customers complete an application form.

⁴⁶⁶ 1st year in service rate is based upon review of PY4-5 evaluations from ComEd's commercial lighting program (BILD) (see 'IL Commercial Lighting ISR.xls' for more information. The average first year ISR was calculated weighted by the number of bulbs sold.

⁴⁶⁷ The 98% Lifetime ISR assumption is based upon review of two evaluations:

'Nexus Market Research, RLW Analytics and GDS Associates study; "New England Residential Lighting Markdown Impact Evaluation, January 20, 2009' and 'KEMA Inc, Feb 2010, Final Evaluation Report:, Upstream Lighting Program, Volume 1.' This implies that only 2% of bulbs purchased are never installed. The second and third year installations are based upon Ameren analysis of the Californian KEMA study showing that 54% of future installs occur in year 2 and 46% in year 3. The 2nd and 3rd year installations should be counted as part of those future program year savings.

⁴⁶⁸ Negative value because this is an increase in heating consumption due to the efficient lighting.

The NTG factor for the Purchase Year should be applied.

SUMMER COINCIDENT DEMAND SAVINGS

$$\Delta kW = ((\text{Watts}_{\text{base}} - \text{Watts}_{\text{EE}}) / 1000) * \text{WHF}_d * \text{CF} * \text{ISR}$$

Where:

WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is selected from the Reference Table in Section 4.5 for each building type. If the building is not cooled WHF_d is 1.

CF = Summer Peak Coincidence Factor for measure is selected from the Reference table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

Other factors as defined above

NATURAL GAS ENERGY SAVINGS

$$\Delta \text{Therms}^{469} = (((\text{Watts}_{\text{Base}} - \text{Watts}_{\text{EE}}) / 1000) * \text{ISR} * \text{Hours} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. This value is selected from the Reference Table in Section 6.5 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

If there are differences between the maintenance of the efficient and baseline lighting system then they should be evaluated on a project-by-project basis.

MEASURE CODE: CI-LTG-MSCI-V02-140601

⁴⁶⁹Negative value because this is an increase in heating consumption due to the efficient lighting.

4.5.9 Multi-Level Lighting Switch

DESCRIPTION

This measure relates to the installation new multi-level lighting switches on an existing lighting system. This measure can only relate to the adding of a new control in an existing building, since multi-level switching is required in the Commercial new construction building energy code (IECC 2012).

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient system is assumed to be a lighting system controlled by multi-level lighting controls.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be an uncontrolled lighting system where all lights in a given area are on the same circuit or all circuits come on at the same time.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for all lighting controls is assumed to be 8 years⁴⁷⁰.

DEEMED MEASURE COST

When available, the actual cost of the measure shall be used. When not available, the incremental capital cost for this measure is assumed to be \$274⁴⁷¹.

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)

⁴⁷⁰ Consistent with Occupancy Sensor control measure.

⁴⁷¹ Goldberg et al, State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Incremental Cost Study, KEMA, October 28, 2009.

- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in the reference section below.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = KW_{Controlled} * Hours * ESF * WHF_e$$

Where:

$KW_{Controlled}$ = Total lighting load connected to the control in kilowatts.

= Actual

Hours = total operating hours of the controlled lighting circuit before the lighting controls are installed. This number should be collected from the customer. Average hours of use per year are provided in the Reference Table in Section 4.5, Fixture annual operating hours, for each building type if customer specific information is not collected. If unknown building type, use the Miscellaneous value.

ESF = Energy Savings factor (represents the percentage reduction to the $KW_{controlled}$ due to the use of multi-level switching).

= Dependent on building type⁴⁷²:

Building Type	Energy Savings Factor (ESF)
Private Office	21.6%
Open Office	16.0%
Retail	14.8%
Classrooms	8.3%
Unknown, average	15%

⁴⁷² Based on results from “Lighting Controls Effectiveness Assessment: Final Report on Bi-Level Lighting Study” published by the California Public Utilities Commission (CPUC), prepared by ADM Associates. <http://lightingcontrolsassociation.org/bi-level-switching-study-demonstrates-energy-savings/>

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is provided in the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{473} = KW_{\text{Controlled}} * \text{Hours} * \text{ESF} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = KW_{\text{controlled}} * \text{ESF} * WHF_d * CF$$

Where:

WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is provided in the Reference Table in Section 4.5. If the building is un-cooled WHF_d is 1.

CF = Summer Peak Coincidence Factor for measure is provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value of 0.66⁴⁷⁴.

NATURAL GAS ENERGY SAVINGS

$$\Delta \text{therms} = KW_{\text{Controlled}} * \text{Hours} * \text{ESF} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting and provided in the Reference Table in Section 4.5 by building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

⁴⁷³Negative value because this is an increase in heating consumption due to the efficient lighting.

⁴⁷⁴ By applying the ESF and the same coincidence factor for general lighting savings we are in essence assuming that the savings from multi-level switching are as likely during peak periods as any other time. In the absence of better information this seems like a reasonable assumption and if anything may be on the conservative side since you might expect the peak periods to be generally sunnier and therefore more likely to have lower light levels. It is also consistent with the control type reducing the wattage lighting load, the same as the general lighting measures.

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-LTG-MLLC-V02-140601

4.5.10 Occupancy Sensor Lighting Controls

DESCRIPTION

This measure relates to the installation of new occupancy sensors on a new or existing lighting system. Lighting control types covered by this measure include wall, ceiling or fixture mounted occupancy sensors. Passive infrared, ultrasonic detectors and fixture-mounted sensors or sensors with a combination thereof are eligible. Lighting controls required by state energy codes are not eligible. This must be a new installation and may not replace an existing lighting occupancy sensor control.

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the existing system is assumed to be manually controlled or an uncontrolled lighting system which is being controlled by one of the lighting controls systems listed above. All sensors must be hard wired and control interior lighting.

A subset of occupancy sensors are those that are programmed as “vacancy” sensors. To qualify as a vacancy sensor, the control must be configured such that manual input is required to turn on the controlled lighting and the control automatically turns the lighting off. Additional savings are achieved compared to standard occupancy sensors because lighting does not automatically turn on and occupants may decide to not turn it on. Note that vacancy sensors are not a viable option for many applications where standard occupancy sensors should be used instead.

DEFINITION OF BASELINE EQUIPMENT

The baseline is assumed to be a lighting system uncontrolled by occupancy.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for all lighting controls is assumed to be 8 years⁴⁷⁵.

DEEMED MEASURE COST

When available, the actual cost of the measure shall be used. When not available, the following default values are provided:

Lighting control type	Cost
Full cost of wall mounted occupancy sensor	\$42 ⁴⁷⁶
Full cost mounted occupancy sensor	\$66 ⁴⁷⁷

⁴⁷⁵ DEER 2008

⁴⁷⁶ Goldberg et al, State of Wisconsin, Public Service Commission of Wisconsin, Focus on Energy Evaluation Business programs Incremental Cost Study, KEMA, October 28, 2009

⁴⁷⁷ Ibid

Full cost of fixture-mounted occupancy sensor	\$125 ⁴⁷⁸
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LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on location.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = KW_{Controlled} * Hours * ESF * WHF_e$$

Where:

$KW_{Controlled}$ = Total lighting load connected to the control in kilowatts. Savings is per control. The total connected load per control should be collected from the customer or the default values presented below used;

Lighting Control Type	Default kw controlled
Wall mounted occupancy sensor	0.350 ⁴⁷⁹

⁴⁷⁸ Efficiency Vermont TRM, October 26, 2011.

⁴⁷⁹ Goldberg et al, State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs, Incremental Cost Study, KEMA, October 28, 2009

Remote mounted occupancy sensor	0.587 ⁴⁸⁰
Fixture mounted sensor	0.073 ⁴⁸¹

Hours = total operating hours of the controlled lighting circuit before the lighting controls are installed. This number should be collected from the customer. Average hours of use per year are provided in the Reference Table in Section 4.5, Fixture annual operating hours, for each building type if customer specific information is not collected. If unknown building type, use the Miscellaneous value.

ESF = Energy Savings factor (represents the percentage reduction to the operating Hours from the non-controlled baseline lighting system).

Lighting Control Type	Energy Savings Factor ⁴⁸²
Wall or Ceiling-Mounted Occupancy Sensors	41% or custom
Fixture Mounted Occupancy Sensors	30% or custom
Wall-Mounted Occupancy Sensors Configured as “Vacancy Sensors”	53% or custom ⁴⁸³

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is provided in the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{484} = KW_{\text{Controlled}} * \text{Hours} * \text{ESF} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

⁴⁸⁰ Ibid

⁴⁸¹ Efficiency Vermont TRM 2/19/2010

⁴⁸² Kuiken, Tammy et al, State of Wisconsin/Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs, Deemed Savings Manual V1.0, PA Consulting Group and KEMA, March 22, 2010 pp 4-192-194.

⁴⁸³ Papamichael, Konstantions, Bi-Level Switching in Office Spaces, California Lighting Technology Center, February 1,2010. Note: See Figure 8 on page 10 for relevant study results. The study shows a 30% extra savings above a typical occupancy sensor; 41% * 1.3 = 53%..

⁴⁸⁴ Negative value because this is an increase in heating consumption due to the efficient lighting.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = KW_{\text{controlled}} * WHF_d * (CF_{\text{baseline}} - CF_{\text{os}})$$

Where:

WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is provided in the Reference Table in Section 4.5. If the building is un-cooled WHF_d is 1.

CF_{baseline} = Baseline Summer Peak Coincidence Factor for the lighting system without Occupancy Sensors installed selected from the Reference Table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66

CF_{os} = Retrofit Summer Peak Coincidence Factor the lighting system with Occupancy Sensors installed is 0.15 regardless of building type.⁴⁸⁵

NATURAL GAS ENERGY SAVINGS

$$\Delta \text{therms} = KW_{\text{Controlled}} * \text{Hours} * \text{ESF} * - \text{IFTherms}$$

Where:

$IFTherms$ = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting and provided in the Reference Table in Section 4.5 by building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-LTG-OSLC-V02-140601

⁴⁸⁵ Coincidence Factor Study Residential and Commercial Industrial Lighting Measures, RLW Analytics, Spring 2007. Note, the connected load used in the calculation of the CF for occupancy sensor lights includes the average ESF.

4.5.11 Solar Light Tubes

DESCRIPTION

A tubular skylight which is 10" to 21" in diameter with a prismatic or translucent lens is installed on the roof of a commercial facility. The lens reflects light captured from the roof opening through a highly specular reflective tube down to the mounted fixture height. When in use, a light tube fixture resembles a metal halide fixture. Uses include grocery, school, retail and other single story commercial buildings.

In order that the savings characterized below apply, the electric illumination in the space must be automatically controlled to turn off or down when the tube is providing enough light.

This measure was developed to be applicable to the following program types: TOS, NC, RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is assumed to be a tubular skylight that concentrates and directs light from the roof to an area inside the facility.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment for this measure is a fixture with comparable luminosity. The specifications for the baseline lamp depend on the size of the Light Tube being installed.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The estimated useful life for a light tube commercial skylight is 10 years⁴⁸⁶.

DEEMED MEASURE COST

If available, the actual incremental cost should be used. For analysis purposes, assume an incremental cost for a light tube commercial skylight is \$500².

LOADSHAPE

Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)⁴⁸⁷

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on location.

⁴⁸⁶ Equal to the manufacturers standard warranty

⁴⁸⁷ The savings from solar light tubes are only realized during the sunlight hours. It is therefore appropriate to apply the single shift (8/5) loadshape to this measure.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kW_f * HOURS * WHF_e$$

Where:

kW_f = Connected load of the fixture the solar tube replaces

Size of Tube	Average Lumen output for Chicago Illinois (minimum) ⁴⁸⁸	Equivalent fixture	kW
21"	9,775 (4,179)	50% 3 x 2 32W lamp CFL (207W, 9915 lumens) 50% 4 lamp F32 w/Elec 4' T8 (114W, 8895 lumens)	0.161
14"	4,392 (1,887)	50% 2 42W lamp CFL (94W, 4406 lumens) 50% 2 lamp F32 w/Elec 4' T8 (59W, 4448 lumens)	0.077
10"	2,157 (911)	50% 1 42W lamp CFL (46W, 2203 lumens) 50% 1 lamp F32 w/Elec 4' T8 (32W, 2224 lumens)	0.039
		AVERAGE	0.092

HOURS = Equivalent full load hours
= 2400⁴⁸⁹

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{490} = kW_f * HOURS * -IFkWh$$

Where:

IFkWh = Lighting-HVAC Iteration Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the

⁴⁸⁸ Solatube Test Report (2005).

http://www.maine绿色建筑.com/files/file/solatube/stb_lumens_datasheet.pdf

⁴⁸⁹ Ibid. The lumen values presented in the kW table represent the average of the lightest 2400 hours.

⁴⁹⁰ Negative value because this is an increase in heating consumption due to the efficient lighting.

Miscellaneous value.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kW_f * WHFd * CF$$

Where:

WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is selected from the Reference Table in Section 4.5 for each building type. If the building is not cooled WHFd is 1.

CF = Summer Peak Coincidence Factor for measure is selected from the Reference Table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

NATURAL GAS SAVINGS

$$\Delta \text{Therms}^{491} = \Delta kW_f * \text{HOURS} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Please select from the Reference Table in Section 4.5 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-LTG-STUB-V02-140601

⁴⁹¹Negative value because this is an increase in heating consumption due to the efficient lighting.

4.5.12 T5 Fixtures and Lamps

DESCRIPTION

T5 Lamp/ballast systems have higher lumens per watt than a standard T8 or an existing T8 or T12 system. The smaller lamp diameter allows for better optical systems, and more precise control of lighting. These characteristics result in light fixtures that produce equal or greater light than standard T8 or T12 fixtures, while using fewer watts.

This measure applies to the installation of new equipment with efficiencies that exceed that of the equipment that would have been installed following standard market practices and is applicable to time of sale as well as retrofit measures.

If the implementation strategy does not allow for the installation location to be known, a deemed split of 98% Commercial and 2% Residential should be used⁴⁹².

This measure was developed to be applicable to the following program types: TOS, RF.
If applied to other program types, the measure savings should be verified.

The measure applies to all commercial T5 installations excluding new construction and substantial renovation or change of use measures (see lighting power density measure). Lookup tables have been provided to account for various installations. Actual existing equipment wattages should be compared to new fixture wattages whenever possible while maintaining lumen equivalent designs. Default new and baseline assumptions are provided if existing equipment cannot be determined. Actual costs and hours of use should be utilized when available. Default component costs and lifetimes have been provided for Operating and Maintenance Calculations. Please see the Definition Table to determine applicability for each program. Configurations not included in the TRM may be included in custom program design using the provided algorithms as long as energy savings is achieved. The following table defines the applicability for different programs:

Time of Sale (TOS)	RETROFIT (RF)
<p>This program applies to installations where customer and location of equipment is not known, or at time of burnout of existing equipment. T5 Lamp/ballast systems have higher lumens per watt than a standard T8 system. The smaller lamp diameter allows for better optical systems, and more precise control of lighting. These characteristics result in light fixtures that produce equal or greater light than standard T8 fixtures, while using fewer watts.</p>	<p>For installations that upgrade installations before the end of their useful life. T5 Lamp/ballast systems have higher lumens per watt than a standard T8 or T12 system. The smaller lamp diameter allows for better optical systems, and more precise control of lighting. These characteristics result in light fixtures that produce equal or greater light than standard T8 or T12 fixtures, while using fewer watts and having longer life.</p>

DEFINITION OF EFFICIENT EQUIPMENT

The definition of efficient equipment varies based on the program and is defined below:

⁴⁹² Based on ComEd’s BILD program data from PY5. For Residential installations, hours of use assumptions from ‘5.5 Interior Hardwired Compact Fluorescent Lamp (CFL) Fixture’ measure should be used.

Time of Sale (TOS)	Retrofit (RF)
4' fixtures must use a T5 lamp and ballast configuration. 1' and 3' lamps are not eligible. High Performance Troffers must be 85% efficient or greater. T5 HO high bay fixtures must be 3, 4 or 6 lamps and 90% efficient or better.	4' fixtures must use a T5 lamp and ballast configuration. 1' and 3' lamps are not eligible. High Performance Troffers must be 85% efficient or greater. T5 HO high bay fixtures must be 3, 4 or 6 lamps and 90% efficient or better.

DEFINITION OF BASELINE EQUIPMENT

The definition of baseline equipment varies based on the program and is defined below:

Time of Sale (TOS)	Retrofit (RF)
The baseline is T8 with equivalent lumen output. In high-bay applications, the baseline is pulse start metal halide systems.	<p>The baseline is the existing system. For T12 systems, the baseline becomes standard T8 in 2016.</p> <p>Retrofits to T12 systems installed before 2016 have a baseline adjustment applied in 2016 for the remainder of the measure life.</p> <p>Due to new federal standards for linear fluorescent lamps, manufacturers of T12 lamps will not be permitted to manufacture most varieties of T12 lamps for sale in the United States after July 2012. All remaining stock and previously manufactured product may be sold after the July 2012 effective date. If a customer relamps an existing T12 fixture the day the standard takes effect, an assumption can be made that they would likely need to upgrade to, at a minimum, 800-series T8s in less than 5 years' time. This assumes the T12s installed have a typical rated life of 20,000 hours and are operated for 4500 hours annually (average miscellaneous hours 4576/year). Certainly, it is not realistic that everyone would wait until the final moment to relamp with T12s. Also, the exempted T12 lamps greater than 87 CRI will continue to be available to purchase, although they will be expensive. Therefore the more likely scenario would be a gradual shift to T8s over the 4 year timeframe. In other words, we can expect that for each year between 2012 and 2016, ~20% of the existing T12 lighting will change over to T8 lamps that comply with the federal standard. To simplify this assumption, we recommend assuming that standard T8s become the baseline for all T12 linear fluorescent retrofit January 1, 2016. There will be a baseline shift applied to all measures installed before 2016 in 2016 in years remaining in the measure life.. See table C-1.</p>

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed lifetime of the efficient equipment fixture, regardless of program type is Fixture lifetime is 15 years⁴⁹³.

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)
- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = ((Watts_{base} - Watts_{EE}) / 1000) * Hours * WHF_e * ISR$$

Where:

Program	Reference Table
Time of Sale	A-1: T5 New and Baseline Assumptions
Retrofit	A-2: T5 New and Baseline Assumptions

⁴⁹³ 15 years from GDS Measure Life Report, June 2007

$Watts_{base}$ = Input wattage of the existing system which depends on the baseline fixture configuration (number and type of lamp) and number of fixtures. Value can be selected from the appropriate reference table as shown below, or a custom value can be entered if the configurations in the tables is not representative of the existing system.

$Watts_{EE}$ = New Input wattage of EE fixture which depends on new fixture configuration (number of lamps) and ballast factor and number of fixtures. Value can be selected from the appropriate reference table as shown below, or a custom value can be entered if the configurations in the tables is not representative of the existing system.

Program	Reference Table
Time of Sale	A-1: T5 New and Baseline Assumptions
Retrofit	A-2: T5 New and Baseline Assumptions

Hours = Average hours of use per year as provided by the customer or selected from the Reference Table in Section 4.5, Fixture annual operating hours, by building type. If hours or building type are unknown, use the Miscellaneous value.

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is selected from the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

ISR = In Service Rate or the percentage of units rebated that get installed.
 =100%⁴⁹⁴ if application form completed with sign off that equipment is not placed into storage

If sign off form not completed assume the following 3 year ISR assumptions:

⁴⁹⁴ Illinois evaluation of PY1 through PY3 has not found that fixtures or lamps placed into storage to be a significant enough issue to warrant including an "In-Service Rate" when commercial customers complete an application form.

Weighted Average 1 st year In Service Rate (ISR)	2 nd year Installations	3 rd year Installations	Final Lifetime In Service Rate
96% ⁴⁹⁵	1.1%	0.9%	98.0% ⁴⁹⁶

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{497} = (((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * -\text{IFkWh}$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

SUMMER COINCIDENT DEMAND SAVINGS

$$\Delta kW = ((\text{Watts}_{\text{base}}-\text{Watts}_{\text{EE}})/1000) * \text{WHF}_d * \text{CF} * \text{ISR}$$

Where:

WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is selected from the Reference Table in Section 4.5 for each building type. If the building is not cooled WHFd is 1.

CF = Summer Peak Coincidence Factor for measure is selected from the Reference Table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

⁴⁹⁵ 1st year in service rate is based upon review of PY4-5 evaluations from ComEd’s commercial lighting program (BILD) (see ‘IL Commercial Lighting ISR.xls’ for more information

⁴⁹⁶ The 98% Lifetime ISR assumption is based upon review of two evaluations: ‘Nexus Market Research, RLW Analytics and GDS Associates study; ‘New England Residential Lighting Markdown Impact Evaluation, January 20, 2009’ and ‘KEMA Inc, Feb 2010, Final Evaluation Report:, Upstream Lighting Program, Volume 1.’ This implies that only 2% of bulbs purchased are never installed. The second and third year installations are based upon Ameren analysis of the Californian KEMA study showing that 54% of future installs occur in year 2 and 46% in year 3. The 2nd and 3rd year installations should be counted as part of those future program year savings.

⁴⁹⁷ Negative value because this is an increase in heating consumption due to the efficient lighting.

NATURAL GAS ENERGY SAVINGS

$$\Delta\text{Therms}^{498} = (((\text{WattsBase}-\text{WattsEE})/1000) * \text{ISR} * \text{Hours} * - \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting. This value is selected from the Reference Table in Section 4.5 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

See Reference tables for Operating and Maintenance Values

Program	Reference Table
Time of Sale	B-1: T5 Component Costs and Lifetime
Retrofit	B-2: T5 Component Costs and Lifetime

REFERENCE TABLES

See following page

⁴⁹⁸Negative value because this is an increase in heating consumption due to the efficient lighting.

A-1: Time of Sale: T5 New and Baseline Assumptions⁴⁹⁹

EE Measure Description	EE Cost	Watts _{EE}	Baseline Description	Base Cost	Watts _{BASE}	Measure Cost	Watts _{SAVE}
2-Lamp T5 High-Bay	\$200.00	180	200 Watt Pulse Start Metal-Halide	\$100.00	232	\$100.00	52
3-Lamp T5 High-Bay	\$200.00	180	200 Watt Pulse Start Metal-Halide	\$100.00	232	\$100.00	52
4-Lamp T5 High-Bay	\$225.00	240	320 Watt Pulse Start Metal-Halide	\$125.00	350	\$100.00	110
6-Lamp T5 High-Bay	\$250.00	360	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	\$150.00	476	\$100.00	116
1-Lamp T5 Troffer/Wrap	\$100.00	32	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	\$60.00	44	\$40.00	12
2-Lamp T5 Troffer/Wrap	\$100.00	64	3-Lamp F32T8 Equivalent w/ Elec. Ballast	\$60.00	88	\$40.00	24
1-Lamp T5 Industrial/Strip	\$70.00	32	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	\$40.00	44	\$30.00	12
2-Lamp T5 Industrial/Strip	\$70.00	64	3-Lamp F32T8 Equivalent w/ Elec. Ballast	\$40.00	88	\$30.00	24
3-Lamp T5 Industrial/Strip	\$70.00	96	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	\$40.00	132	\$30.00	36
4-Lamp T5 Industrial/Strip	\$70.00	128	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	\$40.00	178	\$30.00	50
1-Lamp T5 Indirect	\$175.00	32	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	\$145.00	44	\$30.00	12
2-Lamp T5 Indirect	\$175.00	64	3-Lamp F32T8 Equivalent w/ Elec. Ballast	\$145.00	88	\$30.00	24

⁴⁹⁹ Adapted from Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011.

A-2: Retrofit T5 New and Baseline Assumptions⁵⁰⁰

EE Measure Description	EE Cost	Watts _{EE}	Baseline Description	Watts _{BASE}
3-Lamp T5 High-Bay	\$ 200	180	200 Watt Pulse Start Metal-Halide	232
4-Lamp T5 High-Bay	\$ 225	240	250 Watt Metal-Halide	295
6-Lamp T5 High-Bay	\$ 250	360	320 Watt Pulse Start Metal-Halide	350
			400 Watt Metal halide	455
1-Lamp T5 Troffer/Wrap	\$ 100	32	400 Watt Pulse Start Metal-halide	476
2-Lamp T5 Troffer/Wrap	\$ 100	64		
			1-Lamp F34T12 w/ EEMag Ballast	40
1-Lamp T5 Industrial/Strip	\$ 70	32	2-Lamp F34T12 w/ EEMag Ballast	68
2-Lamp T5 Industrial/Strip	\$ 70	64	3-Lamp F34T12 w/ EEMag Ballast	110
3-Lamp T5 Industrial/Strip	\$ 70	96	4-Lamp F34T12 w/ EEMag Ballast	139
4-Lamp T5 Industrial/Strip	\$ 70	128		
			1-Lamp F40T12 w/ EEMag Ballast	48
1-Lamp T5 Indirect	\$ 175	32	2-Lamp F40T12 w/ EEMag Ballast	82
2-Lamp T5 Indirect	\$ 175	64	3-Lamp F40T12 w/ EEMag Ballast	122
			4-Lamp F40T12 w/ EEMag Ballast	164
			1-Lamp F40T12 w/ Mag Ballast	57
			2-Lamp F40T12 w/ Mag Ballast	94
			3-Lamp F40T12 w/ Mag Ballast	147
			4-Lamp F40T12 w/ Mag Ballast	182
			1-Lamp F32 T8	32
			2-Lamp F32 T8	59
			3-Lamp F32 T18	88
			4-Lamp F32 T8	114

⁵⁰⁰ Ibid.

B-1: Time of Sale T5 Component Costs and Lifetime⁵⁰¹

EE Measure Description	EE Lamp Cost	EE Lamp Life (hrs)	EE Lamp Rep. Labor Cost per lamp	EE Ballast Cost	EE Ballast Life (hrs)	EE Ballast Rep. Labor Cost	Baseline Description	# Base Lamps	Base Lamp Cost	Base Lamp Life (hrs)	Base Lamp Rep. Labor Cost	# Base Ballasts	Base Ballast Cost	Base Ballast Life (hrs)	Base Ballast Rep. Labor Cost
3-Lamp T5 High-Bay	\$12.00	20000	\$6.67	\$52.00	70000	\$22.50	200 Watt Pulse Start Metal-Halide	1.00	\$21.00	10000	\$6.67	1.00	\$87.75	40000	\$22.50
4-Lamp T5 High-Bay	\$12.00	20000	\$6.67	\$52.00	70000	\$22.50	320 Watt Pulse Start Metal-Halide	1.00	\$21.00	20000	\$6.67	1.00	\$109.35	40000	\$22.50
6-Lamp T5 High-Bay	\$12.00	20000	\$6.67	\$52.00	70000	\$22.50	Adjusted according to 6-Lamp HPT8 Equivalent to 320	1.36	\$21.00	20000	\$6.67	1.50	\$109.35	40000	\$22.50
1-Lamp T5 Troffer/Wrap	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	1.50	\$2.50	20000	\$2.67	0.50	\$15.00	70000	\$15.00
2-Lamp T5 Troffer/Wrap	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	3-Lamp F32T8 Equivalent w/ Elec. Ballast	3.00	\$2.50	20000	\$2.67	1.00	\$15.00	70000	\$15.00
1-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	1.50	\$2.50	20000	\$2.67	0.50	\$15.00	70000	\$15.00
2-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	3-Lamp F32T8 Equivalent w/ Elec. Ballast	3.00	\$2.50	20000	\$2.67	1.00	\$15.00	70000	\$15.00
3-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent	4.50	\$2.50	20000	\$2.67	1.50	\$15.00	70000	\$15.00
4-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	6.00	\$2.50	20000	\$2.67	2.00	\$15.00	70000	\$15.00
1-Lamp T5 Indirect	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	1.50	\$2.50	20000	\$2.67	0.50	\$15.00	70000	\$15.00
2-Lamp T5 Indirect	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	3-Lamp F32T8 Equivalent w/ Elec. Ballast	3.00	\$2.50	20000	\$2.67	1.00	\$15.00	70000	\$15.00

⁵⁰¹ Adapted from Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011.

B-2: T5 Retrofit Component Costs and Lifetime⁵⁰²

EE Measure Description	EE Lamp Cost	EE Lamp Life (hrs)	EE Lamp Rep. Labor Cost per lamp	EE Ballast Cost	EE Ballast Life (hrs)	EE Ballast Rep. Labor Cost	Baseline Description	# Base Lamps	Base Lamp Cost	Base Lamp Life (hrs)	Base Lamp Rep. Labor Cost	# Base Ballasts	Base Ballast Cost	Base Ballast Life (hrs)	Base Ballast Rep. Labor Cost
3-Lamp T5 High-Bay	\$12.00	20000	\$6.67	\$52.00	70000	\$22.50	200 Watt Pulse Start Metal-Halide	1.00	\$21.00	10000	\$6.67	1.00	\$ 88	40000	\$22.50
							250 Watt Metal Halide	1.00	\$21.00	10000	\$6.67	1.00	\$ 92	40000	\$22.50
4-Lamp T5 High-Bay	\$12.00	20000	\$6.67	\$52.00	70000	\$22.50	320 Watt Pulse Start Metal-Halide	1.00	\$72.00	20000	\$6.67	1.00	\$ 109	40000	\$22.50
							400 Watt Metal Halide	1.00	\$17.00	20000	\$6.67	1.00	\$ 114	40000	\$22.50
6-Lamp T5 High-Bay	\$12.00	20000	\$6.67	\$52.00	70000	\$22.50	Proportionally Adjusted according to 6-Lamp HPT8 Equivalent to 320 PSMH	1.36	\$72.00	20000	\$6.67	1.50	\$ 109	40000	\$22.50
1-Lamp T5 Troffer/Wrap	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	1.50	\$2.50	20000	\$2.67	0.50	\$ 15	70000	\$15.00
2-Lamp T5 Troffer/Wrap	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	3-Lamp F32T8 Equivalent w/ Elec. Ballast	3.00	\$2.50	20000	\$2.67	1.00	\$ 15	70000	\$15.00
1-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	1.50	\$2.50	20000	\$2.67	0.50	\$ 15	70000	\$15.00
2-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	3-Lamp F32T8 Equivalent w/ Elec. Ballast	3.00	\$2.50	20000	\$2.67	1.00	\$ 15	70000	\$15.00
3-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	4.50	\$2.50	20000	\$2.67	1.50	\$ 15	70000	\$15.00
4-Lamp T5 Industrial/Strip	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	6.00	\$2.50	20000	\$2.67	2.00	\$ 15	70000	\$15.00
1-Lamp T5 Indirect	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	Proportionally adjusted according to 2-Lamp T5 Equivalent to 3-Lamp T8	1.50	\$2.50	20000	\$2.67	0.50	\$ 15	70000	\$15.00
2-Lamp T5 Indirect	\$12.00	20000	\$2.67	\$52.00	70000	\$15.00	3-Lamp F32T8 Equivalent w/ Elec. Ballast	3.00	\$2.50	20000	\$2.67	1.00	\$ 15	70000	\$15.00

⁵⁰² Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, October 26, 2011 EPE Program Downloads. Web accessed <http://www.epelectricefficiency.com/downloads.asp?section=ci> download Copy of LSF_2012_v4.04_250rows.xls. Kuiken et al, Focus on Energy Evaluation. Business Programs: Deemed Savings Manual v1.0, Kema, march 22, 2010 available at http://www.focusonenergy.com/files/Document_Management_System/Evaluation/bpdeemedsavingsmanuav10_evaluationreport.pdf

C-1: T12 Baseline Adjustment:

Savings Adjustment Factors

	watts	Equivalent T12 watts adjusted for lumen equivalency-34 w and 40 w with EEMag ballast	Equivalent T12 watts adjusted for lumen equivalency-40 w with EEMag ballast	Equivalent T12 watts adjusted for lumen equivalency-40 w with Mag ballast	Prportionally Adjusted for Lumens wattage for T8 equivalent
1-Lamp T5 Industrial/Strip	32	61	73	82	44
2-Lamp T5 Industrial/Strip	64	103	125	135	88
3-Lamp T5 Industrial/Strip	96	167	185	211	132
4-Lamp T5 Industrial/Strip	128	211	249	226	178
		Savings Factor Adjustment to the T8 baseline	Savings Factor Adjustment to the T8 baseline	Savings Factor Adjustment to the T8 baseline	
1-Lamp T5 Industrial/Strip		42%	29%	24%	
2-Lamp T5 Industrial/Strip		61%	40%	34%	
3-Lamp T5 Industrial/Strip		51%	40%	31%	
4-Lamp T5 Industrial/Strip		60%	41%	51%	

Measures installed in 2012 will claim full savings for four years, 2013 for three years, 2014 two years and 2015 one year. Savings adjustment factors based on a T8 baseline will be applied to the full savings for savings starting in 2016 and for the remainder of the measure life. The adjustment to be applied for each measure is listed in the reference table above and is based on equivalent lumens.

MEASURE CODE: CI-LTG-T5FX-V02-140601

4.5.13 Occupancy Controlled Bi-Level Lighting Fixtures

DESCRIPTION

This measure relates to replacing existing uncontrolled continuous lighting fixtures with new bi-level lighting fixtures. This measure can only relate to replacement in an existing building, since multi-level switching is required in the Commercial new construction building energy code (IECC 2012).

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient system is assumed to be an occupancy controlled lighting fixture that reduces light level during unoccupied periods.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is assumed to be an uncontrolled lighting system on continuously, e.g. in stairwells and corridors for health and safety reasons.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life for all lighting controls is assumed to be 8 years⁵⁰³.

DEEMED MEASURE COST

When available, the actual cost of the measure shall be used. When not available, the assumed measure cost is \$274⁵⁰⁴.

LOADSHAPE

- Loadshape C06 - Commercial Indoor Lighting
- Loadshape C07 - Grocery/Conv. Store Indoor Lighting
- Loadshape C08 - Hospital Indoor Lighting
- Loadshape C09 - Office Indoor Lighting
- Loadshape C10 - Restaurant Indoor Lighting
- Loadshape C11 - Retail Indoor Lighting
- Loadshape C12 - Warehouse Indoor Lighting
- Loadshape C13 - K-12 School Indoor Lighting
- Loadshape C14 - Indust. 1-shift (8/5) (e.g., comp. air, lights)
- Loadshape C15 - Indust. 2-shift (16/5) (e.g., comp. air, lights)

⁵⁰³ DEER 2008.

⁵⁰⁴ Consistent with the Multi-level Fixture measure with reference to Goldberg et al, State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs: Incremental Cost Study, KEMA, October 28, 2009. Also consistent with field experience of about \$250 per fixture and \$25 install labor.

- Loadshape C16 - Indust. 3-shift (24/5) (e.g., comp. air, lights)
- Loadshape C17 - Indust. 4-shift (24/7) (e.g., comp. air, lights)
- Loadshape C18 - Industrial Indoor Lighting
- Loadshape C19 - Industrial Outdoor Lighting
- Loadshape C20 - Commercial Outdoor Lighting

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is dependent on the location type. Values are provided for each building type in the reference section below.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = (KW_{Baseline} - (KW_{Controlled} * (1 - ESF))) * Hours * WHF_e$$

Where:

$KW_{Baseline}$ = Total baseline lighting load of the existing/baseline fixture

= Actual

Note that if the existing fixture is only being retrofit with bi-level occupancy controls and not being replaced $KW_{Baseline}$ will equal $KW_{Controlled}$.

$KW_{Controlled}$ = Total controlled lighting load at full light output of the new bi-level fixture

= Actual

Hours = Number of hours lighting is on. This measure is limited to 24/7 operation.

= 8,766

ESF = Energy Savings factor (represents the percentage reduction to the $KW_{Controlled}$ due to the occupancy control).

= % Standby Mode * (1 - % Full Light at Standby Mode)

% Standby Mode = Represents the percentage of the time the fixture is operating in standby (i.e. low-wattage) mode.

% Full Light at Standby Mode = Represents the assumed wattage consumption during standby mode relative to the full wattage consumption. Can be achieved either through dimming or a stepped control strategy.

= Dependent on application. If customer provided or metered data is available for both or either of these inputs a custom savings factor should be calculated. If not defaults are provided below:

Application	% Standby Mode	% Full Light at Standby Mode	Energy Savings Factor (ESF)
Stairwells	78.5% ⁵⁰⁵	50%	39.3%
		33%	52.6%
		10%	70.7%
		5%	74.6%
Corridors	50.0% ⁵⁰⁶	50%	25.0%
		33%	33.5%
		10%	45.0%
		5%	47.5%
Other 24/7 Space Type	50.0% ⁵⁰⁷	50%	25.0%
		33%	33.5%
		10%	45.0%
		5%	47.5%

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is provided in the Reference Table in Section 4.5 for each building type. If building is un-cooled, the value is 1.0.

HEATING PENALTY

If electrically heated building:

$$\Delta kWh_{\text{heatpenalty}}^{508} = (KW_{\text{Baseline}} - (KW_{\text{Controlled}} * (1 - ESF))) * \text{Hours} * -IFkWh$$

Where:

IFkWh = Lighting-HVAC Interaction Factor for electric heating impacts; this factor represents the increased electric space heating requirements due to the reduction of waste heat rejected by the efficient lighting. Values are provided in the Reference Table in Section 4.5. If unknown, use the Miscellaneous value.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (KW_{\text{Baseline}} - (KW_{\text{Controlled}} * (1 - ESF))) * WHF_d * (CF_{\text{baseline}} - CF_{\text{os}})$$

⁵⁰⁵ Average found from the four buildings in the State of California Energy Commission Lighting Research Program Bi-Level Stairwell Fixture Performance Final Report:

http://www.archenergy.com/lrp/lightingperf_standards/project_5_1_reports.htm

⁵⁰⁶ Value determined from the Pacific Gas and Electric Company: Bi-Level Lighting Control Credits study for Interior Corridors of Hotels, Motels and High Rise Residential.

http://www.energy.ca.gov/title24/2005standards/archive/documents/2002-07-18_workshop/2002-07-18_BILEVEL_LIGHTING.PDF

⁵⁰⁷ Conservative estimate.

⁵⁰⁸ Negative value because this is an increase in heating consumption due to the efficient lighting.

Where:

- WHF_d = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is provided in the Reference Table in Section 4.5. If the building is un-cooled WHF_d is 1.
- $CF_{baseline}$ = Baseline Summer Peak Coincidence Factor for the lighting system without Occupancy Sensors installed selected from the Reference Table in Section 4.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66
- CF_{os} = Retrofit Summer Peak Coincidence Factor the lighting system with Occupancy Sensors installed is 0.15 regardless of building type.⁵⁰⁹

NATURAL GAS HEATING PENALTY

If natural gas heating:

$$\Delta\text{therms} = (KW_{\text{Baseline}} - (KW_{\text{Controlled}} * (1 - \text{ESF}))) * \text{Hours} * \text{IFTherms}$$

Where:

IFTherms = Lighting-HVAC Integration Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting and provided in the Reference Table in Section 4.5 by building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-LTG-OCBL-V01-140601

⁵⁰⁹ Coincidence Factor Study Residential and Commercial Industrial Lighting Measures, RLW Analytics, Spring 2007. Note, the connected load used in the calculation of the CF for occupancy sensor lights includes the average ESF.

4.6 Refrigeration End Use

4.6.1 Automatic Door Closer for Walk-In Coolers and Freezers

DESCRIPTION

This measure is for installing an auto-closer to the main insulated opaque door(s) of a walk-in cooler or freezer. The auto-closer must firmly close the door when it is within 1 inch of full closure.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

This measure consists of the installation of an automatic, hydraulic-type door closer on main walk-in cooler or freezer doors. These closers save energy by reducing the infiltration of warm outside air into the refrigeration itself.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline condition is assumed to be a walk in cooler or freezer without an automatic closure.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed measure life is 8 years.⁵¹⁰

DEEMED MEASURE COST

The deem measure cost is \$156.82 for a walk-in cooler or freezer.⁵¹¹

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

The measure has deemed kW savings therefore a coincidence factor does not apply

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

Savings calculations are based on values from through PG&E's Workpaper PGECOREF110.1 – Auto-Closers for Main

⁵¹⁰ Source: DEER 2008

⁵¹¹ Ibid.

Cooler or Freezer Doors. Savings are averaged across all California climate zones and vintages⁵¹².

Annual Savings	kWh
Walk in Cooler	943 kWh
Walk in Freezer	2307 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

Annual Savings	kW
Walk in Cooler	0.137 kW
Walk in Freezer	0.309 kW

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-ATDC-V01-120601

⁵¹² Measure savings from ComEd TRM developed by KEMA. June 1, 2010

4.6.2 Beverage and Snack Machine Controls

DESCRIPTION

This measure relates to the installation of new controls on refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. Controls can significantly reduce the energy consumption of vending machine and refrigeration systems. Qualifying controls must power down these systems during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure relates to the installation of a new control on a new or existing unit. This measure should **not** be applied to ENERGY STAR qualified vending machines, as they already have built-in controls.

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 5 years⁵¹³.

DEEMED MEASURE COST

The actual measure installation cost should be used (including material and labor), but the following can be assumed for analysis purposes⁵¹⁴:

Refrigerated Vending Machine and Glass Front Cooler: \$180.00

Non-Refrigerated Vending Machine: \$80.00

LOADSHAPE

Loadshape C52 - Beverage and Snack Machine Controls

⁵¹³ Measure Life Study, prepared for the Massachusetts Joint Utilities, Energy & Resource Solutions, November 2005.

⁵¹⁴ ComEd workpapers, 8—15-11.pdf

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is assumed to be 0⁵¹⁵.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = WATTsbase / 1000 * HOURS * ESF$$

Where:

WATTsbase = connected W of the controlled equipment; see table below for default values by connected equipment type:

Equipment Type	WATTsbase ⁵¹⁶
Refrigerated Beverage Vending Machines	400
Non-Refrigerated Snack Vending Machines	85
Glass Front Refrigerated Coolers	460

1000 = conversion factor (W/kW)

HOURS = operating hours of the connected equipment; assumed that the equipment operates 24 hours per day, 365.25 days per year

$$= 8766$$

ESF = Energy Savings Factor; represents the percent reduction in annual kWh consumption of the equipment controlled; see table below for default values:

Equipment Type	Energy Savings Factor (ESF) ⁵¹⁷
Refrigerated Beverage Vending Machines	46%
Non-Refrigerated Snack Vending Machines	46%
Glass Front Refrigerated Coolers	30%

⁵¹⁵ Assumed that the peak period is coincident with periods of high traffic diminishing the demand reduction potential of occupancy based controls.

⁵¹⁶ USA Technologies Energy Management Product Sheets, July 2006; cited September 2009. <http://www.usatech.com/energy_management/energy_productsheets.php>

⁵¹⁷ Ibid.

EXAMPLE

For example, adding controls to a refrigerated beverage vending machine:

$$\begin{aligned}\Delta\text{kWh} &= \text{WATTS}_{\text{base}} / 1000 * \text{HOURS} * \text{ESF} \\ &= 400/1000 * 8766 * .46 = 1.6 \text{ kWh}\end{aligned}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-BEVM-V01-120601

4.6.3 Door Heater Controls for Cooler or Freezer

DESCRIPTION

By installing a control device to turn off door heaters when there is little or no risk of condensation, one can realize significant energy savings. There are two commercially available control strategies that achieve “on-off” control of door heaters based on either (1) the relative humidity of the air in the store or (2) the “conductivity” of the door (which drops when condensation appears). In the first strategy, the system activates your door heaters when the relative humidity in your store rises above a specific setpoint, and turns them off when the relative humidity falls below that setpoint. In the second strategy, the sensor activates the door heaters when the door conductivity falls below a certain setpoint, and turns them off when the conductivity rises above that setpoint.

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

In order for this characterization to apply, the efficient equipment is assumed to be a door heater control on a commercial glass door cooler or refrigerator utilizing humidity or conductivity control.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline condition is assumed to be a commercial glass door cooler or refrigerator with a standard heated door with no controls installed.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 12 years⁵¹⁸.

DEEMED MEASURE COST

The incremental capital cost for a humidity-based control is \$300 per circuit regardless of the number of doors controlled. The incremental cost for conductivity-based controls is \$200⁵¹⁹.

LOADSHAPE

Loadshape C51 - Door Heater Control

COINCIDENCE FACTOR⁵²⁰

The summer peak coincidence factor for this measure is assumed to be 0%⁵²¹.

⁵¹⁸ 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, “Effective/Remaining Useful Life Values”, California Public Utilities Commission, December 16, 2008.

⁵¹⁹ Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010

⁵²⁰ Source partial list from DEER 2008

⁵²¹ Based on the assumption that humidity levels will most likely be relatively high during the peak period, reducing

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta\text{kWH} = \text{kWbase} * \text{NUMdoors} * \text{ESF} * \text{BF} * 8760$$

Where:

kWbase^{522} = connected load kW for typical reach-in refrigerator or freezer door and frame with a heater.

= If actual kWbase is unknown, assume 0.195 kW for freezers and 0.092 kW for coolers.

NUMdoors = number of reach-in refrigerator or freezer doors controlled by sensor

= Actual installed

ESF^{523} = Energy Savings Factor; represents the percentage of hours annually that the door heater is powered off due to the controls.

= assume 55% for humidity-based controls, 70% for conductivity-based controls

BF^{524} = Bonus Factor; represents the increased savings due to reduction in cooling load inside the cases, and the increase in cooling load in the building space to cool the additional heat generated by the door heaters.

the likelihood of demand savings from door heater controls.

⁵²² A review of TRM methodologies from Vermont, New York, Wisconsin, and Connecticut reveals several different sources for this factor. Connecticut requires site-specific information, whereas New York's characterization does not explicitly identify the kWbase. Connecticut and Vermont provide values that are very consistent, and the simple average of these two values has been used for the purposes of this characterization.

⁵²³ A review of TRM methodologies from Vermont, New York, Wisconsin, and Connecticut reveals several different estimates of ESF. Vermont is the only TRM that provides savings estimates dependent on the control type. Additionally, these estimates are the most conservative of all TRMs reviewed. These values have been adopted for the purposes of this characterization.

⁵²⁴ Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010

Definition	Representative Evaporator Temperature Range, °F ⁵²⁵	Typical Uses	BF
Low	-35 to 0	Freezers for times such as frozen pizza, ice cream, etc.	1.36
Medium	0 – 20	Coolers for items such as meat, milk, dairy, etc	1.22
High	20 – 45	Coolers for items such as floral, produce and meat preparation rooms	1.15

8760 = annual hours of operation

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

Deemed O&M Cost Adjustment Calculation

N/A

MEASURE CODE: CI-RFG-DHCT-V01-120601

⁵²⁵ Energy Efficiency Supermarket Refrigeration, Wisconsin Electric Power Company, July 23, 1993

4.6.4 Electronically Commutated Motors (ECM) for Walk-in and Reach-in Coolers / Freezers

DESCRIPTION

This measure is applicable to the replacement of an existing standard-efficiency shaded-pole evaporator fan motor in refrigerated display cases or fan coil in walk-ins.

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

This measure applies to the replacement of an existing standard-efficiency shaded-pole evaporator fan motor in refrigerated display cases or fan coil in walk-ins. The replacement unit must be an electronically commutated motor (ECM). This measure cannot be used in conjunction with the evaporator fan controller measure

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline equipment is assumed to be a shaded pole motor

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years⁵²⁶

DEEMED MEASURE COST

The measure cost is assumed to be \$50 for a walk in cooler and walk in freezer.⁵²⁷

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

The measure has deemed peak kW savings therefore a coincidence factor does not apply.

Algorithm

CALCULATION OF SAVINGS⁵²⁸

Savings values are obtained from the SCE workpaper for efficient evaporator fan motors, which covers all 16 California climate zones. SCE savings values were determined using a set of assumed conditions for restaurants and grocery stores. We have used only PG&E climate zones in calculating our averages and have taken out the drier, warmer climates of southern California. SCE's savings approach calculates refrigeration demand, by taking

⁵²⁶ DEER

⁵²⁷ Act on Energy Commercial Technical Reference Manual No. 2010-4

⁵²⁸ "Efficient Evaporator Fan Motors (Shaded Pole to ECM)," Workpaper WPSCNRRN0011. Southern California Edison Company. 2007.

Illinois Statewide Technical Reference Manual - 4.6.4 Electronically Commutated Motors (ECM) for Walk-in and Reach-in Coolers / Freezers

into consideration temperature, compressor efficiency, and various loads involved for both walk-in and reach-in refrigerators. Details on cooling load calculations, including refrigeration conditions, can be found in the SCE workpaper. The baseline for this measure assumes that the refrigeration unit has a shaded-pole motor. The following tables are values calculated within the SCE workpaper.

Table 156 SCE Restaurant Savings Walk-In

SCE Workpaper Values Northern California Climate Zones	Restaurant			
	Cooler		Freezer	
	kWh Savings Per Motor	Peak kW Savings Per Motor	kWh Savings Per Motor	Peak kW Savings Per Motor
1	318	0.0286	507	0.03
2	253	0.033	263	0.037
3	364	0.0315	649	0.034
4	365	0.0313	652	0.034
5	350	0.0305	605	0.033
11	410	0.0351	780	0.04
12	399	0.034	748	0.039
13	407	0.0342	771	0.039
16	354	0.0315	620	0.034
Average	358	0.0322	622	0.036

Illinois Statewide Technical Reference Manual - 4.6.4 Electronically Commutated Motors (ECM) for Walk-in and Reach-in Coolers / Freezers

Table 157: SCE Grocery Savings Walk-In

	Grocery			
SCE Workpaper Values	Cooler		Freezer	
Northern California Climate Zones	kWh Savings Per Motor	Peak kW Savings Per Motor	kWh Savings Per Motor	Peak kW Savings Per Motor
1	318	0.0284	438	0.03
2	252	0.0534	263	0.064
3	364	0.0486	552	0.056
4	365	0.048	553	0.055
5	349	0.0452	516	0.051
11	410	0.0601	656	0.074
12	398	0.0566	631	0.069
13	406	0.0574	649	0.07
16	354	0.0486	528	0.056
Average	357	0.0496	532	0.058

Table 158: SCE Grocery Savings Reach-In

	Grocery			
SCE Workpaper Values	Cooler		Freezer	
Northern California Climate Zones	kWh Savings Per Motor	Peak kW Savings Per Motor	kWh Savings Per Motor	Peak kW Savings Per Motor
1	306	0.031	362	0.031
2	269	0.033	273	0.035
3	331	0.032	421	0.034
4	332	0.032	422	0.034
5	323	0.032	402	0.033
11	357	0.034	476	0.037
12	350	0.034	462	0.036
13	355	0.034	472	0.037
16	325	0.032	409	0.034
Average	328	0.033	411	0.035

Savings values in the following table are an average of walk-in cooler (80 percent) and freezer (20 percent) applications. The workpapers for the 2006-2008 program years include this distribution of coolers and freezers in their refrigeration measure savings analyses.

ELECTRIC ENERGY SAVINGS

The following table provides the kWh savings.

Building type	kWh Savings/ft
Restaurant	411
Grocery	392
Average	401

SUMMER COINCIDENT PEAK DEMAND SAVINGS

The following table provides the kW savings

Building Type	Peak kW Savings/motor
Restaurant	0.033
Grocery	0.051
Average	0.042

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-ECMF-V01-120601

4.6.5 ENERGY STAR Refrigerated Beverage Vending Machine

DESCRIPTION

ENERGY STAR qualified new and rebuilt vending machines incorporate more efficient compressors, fan motors, and lighting systems as well as low power mode option that allows the machine to be placed in low-energy lighting and/or low-energy refrigeration states during times of inactivity.

This measure was developed to be applicable to the following program types: TOS, NC .
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The refrigerated vending machine can be new or rebuilt but must meet the ENERGY STAR specifications which include low power mode.

DEFINITION OF BASELINE EQUIPMENT

The baseline vending machine is a standard unit

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed lifetime of this measure is 14 years⁵²⁹

DEEMED MEASURE COST

The incremental cost of this measure is \$500⁵³⁰

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

It is assumed that controls are only effective during off-peak hours and so have no peak-kW savings.

Algorithm

CALCULATION OF SAVINGS

Beverage machine savings are taken from the ENERGY STAR savings calculator and summarized in the following table. ENERGY STAR provides savings numbers for machines with and without control software. The average savings are calculated here.

⁵²⁹ ENERGY STAR

⁵³⁰ ENERGY STAR

ELECTRIC ENERGY SAVINGS

ENERGY STAR Vending Machine Savings⁵³¹

Vending Machine Capacity (cans)	kWh Savings Per Machine w/o software	kWh Savings Per Machine w/ software
<500	1,099	1,659
500	1,754	2,231
699	1,242	1,751
799	1,741	2,283
800+	713	1,288
Average	1,310	1,842

SUMMER COINCIDENT PEAK DEMAND SAVINGS

N/A

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-ESVE-V01-120601

⁵³¹ Savings from Vending Machine Calculator:
http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=VMC

4.6.6 Evaporator Fan Control

DESCRIPTION

This measure is for the installation of controls in existing medium temperature walk-in coolers. The controller reduces airflow of the evaporator fans when there is no refrigerant flow.

This measure was developed to be applicable to the following program types: RF.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The measure must control a minimum of 1/20 HP where fans operate continuously at full speed. The measure also must reduce fan motor power by at least 75% during the off cycle. This measure is not applicable if any of the following conditions apply:

- The compressor runs all the time with high duty cycle
- The evaporator fan does not run at full speed all the time
- The evaporator fan motor runs on poly-phase power
- Evaporator does not use off-cycle or time-off defrost.

DEFINITION OF BASELINE EQUIPMENT

In order for this characterization to apply, the baseline measure is assumed to be a cooler with continuously running evaporator fan. An ECM can also be updated with controls.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 16 years⁵³²

DEEMED MEASURE COST

The measure cost is assumed to be \$291⁵³³

LOADSHAPE

Loadshape C46 - Evaporator Fan Control

COINCIDENCE FACTOR

The measure has deemed kW savings therefore a coincidence factor does not apply.

⁵³² Source: DEER

⁵³³ Source: DEER

Algorithm

CALCULATION OF SAVINGS

Savings for this measure were obtained from the DEER database and are summarized in the following table. The baseline is assumed to be evaporator fans that run continuously with either a permanent split capacitor or shaded-pole motors. In the energy-efficient case the fan is still assumed to operate even with the evaporator inactive⁵³⁴.

ELECTRIC ENERGY SAVINGS

DEER provides savings numbers for building vintages and grocery only. The numbers above are averages of these vintages. We are assuming that this measure will be applicable for all building types

The following table provides the kWh savings

Northern California Climate Zones	kWh Savings Per Motor
1	480
2	476
3	479
4	475
5	477
11	476
12	476
13	476
16	483
Average	478

⁵³⁴ 2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report

SUMMER COINCIDENT PEAK DEMAND SAVINGS

The following table provides the kW savings

Northern California Climate Zones	Peak kW Savings Per Motor
1	0.057
2	0.064
3	0.062
4	0.061
5	0.056
11	0.058
12	0.065
13	0.061
16	0.061
Average	0.06

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-EVPF-V01-120601

4.6.7 Strip Curtain for Walk-in Coolers and Freezers

DESCRIPTION

This commercial measure pertains to the installation of infiltration barriers (strip curtains) on walk-in coolers or freezers. Strip curtains impede heat transfer from adjacent warm and humid spaces into walk-ins when the main door is opened, thereby reducing the cooling load. As a result, compressor run time and energy consumption are reduced. The engineering assumption is that the walk-in door is open 72 minutes per day every day, and the strip curtain covers the entire door frame.

This measure was developed to be applicable to the following program types: RF.

If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The efficient equipment is a polyethylene strip curtain added to a walk-in cooler or freezer

DEFINITION OF BASELINE EQUIPMENT

The baseline assumption is a walk-in cooler or freezer that previously had either no strip curtain installed or an old, ineffective strip curtain installed.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 6 years⁵³⁵.

DEEMED MEASURE COST

The incremental capital cost for this measure is \$286.16⁵³⁶

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is 100%⁵³⁷.

⁵³⁵ M. Goldberg, J. Ryan Barry, B. Dunn, M. Ackley, J. Robinson, and D. Deangelo-Woolsey, KEMA. "Focus on Energy: Business Programs – Measure Life Study", August 2009.

⁵³⁶ Assume average walk in door size is 3.5 feet wide and 8 feet tall or 28 square feet. The reference for incremental cost is \$10.22 per square foot of door opening (includes material and labor). 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Cost Values and Summary Documentation", California Public Utilities Commission, December 16, 2008, Therefore incremental cost per door is \$286.16

⁵³⁷ The summer coincident peak demand reduction is assumed as the total annual savings divided by the total number of hours per year, effectively assuming the average demand reduction is realized during the peak period. This is a reasonable assumption for refrigeration savings.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS⁵³⁸

ΔkWh = 2,974 per freezer with curtains installed
= 422 per cooler with curtains installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = $\Delta kWh / 8760 * CF$
= 0.35 for freezers
= 0.05 for coolers

Where:

8766 = hours per year
CF = Summer Peak Coincidence Factor for the measure
= 1.0

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-CRTN-V02-130601

⁵³⁸ Values based on analysis prepared by ADM for FirstEnergy utilities in Pennsylvania, provided via personal communication with Diane Rapp of FirstEnergy on June 4, 2010. Based on a review of deemed savings assumptions and methodologies from Oregon and California, the values from Pennsylvania appear reasonable and are the most applicable.

4.6.8 Refrigeration Economizers

DESCRIPTION

This measure applies to commercial walk in refrigeration systems and includes two components, outside air economizers and evaporator fan controllers. Economizers save energy by bringing in outside air when weather conditions allow, rather than operating the compressor. Walk-in refrigeration systems evaporator fans run almost all the time; 24 hrs/day, 365 days/yr. This is because they must run constantly to provide cooling when the compressor is running, and to provide air circulation when the compressor is not running. However, evaporator fans are a very inefficient method of providing air circulation. Installing an evaporator fan control system will turn off evaporator fans while the compressor is not running, and instead turn on an energy-efficient 35 watt fan to provide air circulation, resulting in significant energy savings. This measure allows for economizer systems with evaporator fan controls plus a circulation fan and without a circulation fan.

DEFINITION OF EFFICIENT EQUIPMENT

To qualify for this measure an economizer is installed on a walk in refrigeration system.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is a walk-in refrigeration system without an economizer

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The estimated life of this measure is 15 years⁵³⁹.

DEEMED MEASURE COST

The installation cost for an economizer is \$2,558.⁵⁴⁰

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is assumed to be 0%⁵⁴¹.

Algorithm

CALCULATION OF ENERGY SAVINGS

ELECTRIC ENERGY SAVINGS

Electric energy savings is calculated based on whether evaporator fans run all

⁵³⁹ Estimated life from Efficiency Vermont TRM

⁵⁴⁰ Based on average of costs from Freeaire, Natural Cool, and Cooltrol economizer systems.

⁵⁴¹ Based on the assumption that humidity levels will most likely be relatively high during the peak period, reducing the likelihood of demand savings.

With Fan Control Installed

$$\Delta kWh = [HP \times kWhCond] + [(kWEvap \times nFans) - kWCirc] \times Hours \times DCComp \times BF - [kWEcon \times DCEcon \times Hours]$$

Without Fan Control Installed

$$\Delta kWh = [HP \times kWhCond] - [kWEcon \times DCEcon \times Hours]$$

Where:

HP = Horsepower of Compressor
= actual installed

kWhCond = Condensing unit savings, per hp. (value from savings table)⁵⁴²

	Hemetic/ Semi- Hemetic	Scroll	Discus
kWh / HP	1,256	1,108	1,051

Hours = Number of annual hours that economizer operates⁵⁴³.

Region (city)	Hours
1 (Rockford)	2,376
2 (Chicago/O'Hare)	1,968
3 (Springfield)	1,728
4 (Bellevue)	1,488
5 (Marion)	1,224

DCComp = Duty cycle of the compressor
= 50%⁵⁴⁴

kWEvap = Connected load kW of each evaporator fan,
= If known, actual installed. Otherwise assume 0.123 kW⁵⁴⁵

kWCirc = Connected load kW of the circulating fan

⁵⁴² Savings table uses Economizer Calc.xls. Assume 5HP compressor size used to develop kWh/Hp value. No floating head pressure controls and compressor is located outdoors

⁵⁴³ In the source TRM (VT) this value was 2,996 hrs based on 38° F cooler setpoint, Burlington VT weather data, and 5 degree economizer deadband. The IL numbers were calculated by using weather bin data for each location (number of hours < 38F at each location is the Hours value).

⁵⁴⁴ A 50% duty cycle is assumed based on examination of duty cycle assumptions from Richard Travers (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. (as referenced by the Efficiency Vermont, Technical Reference User Manual)

⁵⁴⁵ Based on an a weighted average of 80% shaded pole motors at 132 watts and 20% PSC motors at 88 watts

= If known, actual installed. Otherwise assume 0.035 kW⁵⁴⁶

nFans = Number of evaporator fans
= actual number of evaporator fans

DCEcon = Duty cycle of the economizer fan on days that are cool enough for the economizer to be working
= If known, actual installed. Otherwise assume 63%⁵⁴⁷

BF = Bonus factor for reduced cooling load from running the evaporator fan less or (1.3)⁵⁴⁸

kWEcon = Connected load kW of the economizer fan
= If known, actual installed. Otherwise assume 0.227 kW.⁵⁴⁹

EXAMPLE

For example, adding an outdoor air economizer and fan controls in Rockford to a 5 hp walk in refrigeration unit with 3 evaporator fans would save:

$$\begin{aligned} \Delta kWh &= [HP * kWhCond] + [((kWEvap * nFans) * Hours * DCComp * BF) - [kWEcon * DCEcon * Hours]] \\ &= [5 * 1256] + [((0.123 * 3) * 2376 * 0.5 * 1.3) - [0.227 * .63 * 2376]] \\ &= 6510 kWh \end{aligned}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh / \text{Hours}$$

NATURAL GAS SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-RFG-ECON-V04-140601

⁵⁴⁶ Wattage of fan used by Freeaire and Cooltrol. This fan is used to circulate air in the cooler when the evaporator fan is turned off. As such, it is not used when fan control is not present

⁵⁴⁷ Average of two manufacturer estimates of 50% and 75%.

⁵⁴⁸ Bonus factor (1+ 1/3.5) assumes COP of 3.5, based on the average of standard reciprocating and discus compressor efficiencies with a Saturated Suction Temperature of 20°F and a condensing temperature of 90°F

⁵⁴⁹ The 227 watts for an economizer is calculated from the average of three manufacturers: Freeaire (186 Watts), Cooltrol (285 Watts), and Natural Cool (218 Watts).

4.7 Miscellaneous End Use

4.7.1 VSD Air Compressor

DESCRIPTION

This measure relates to the installation of an air compressor with a variable frequency drive, load/no load controls or variable displacement control. The baseline compressors defined choke off the inlet air to modulate the compressor output, which is not efficient. Efficient compressors use a variable speed drive on the motor to match output to the load. Savings are calculated using representative baseline and efficient demand numbers for compressor capacities according to the facility's load shape, and the number of hours the compressor runs at that capacity. Demand curves are as per DOE data for a Variable Speed compressor versus a Modulating compressor. This measure applies only to an individual compressor ≤ 40 hp

This measure was developed to be applicable to the following program types: TOS.
If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

The high efficiency equipment is a compressor ≤ 40 hp with variable speed control.

DEFINITION OF BASELINE EQUIPMENT

The baseline equipment is a modulating compressor with blow down ≤ 40 hp

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

10 years.

DEEMED MEASURE COST

IncrementalCost (\$) = $(127 \times \text{hp}_{\text{compressor}}) + 1446$

Where:

127 and 1446⁵⁵⁰ = compressor motor nominal hp to incremental cost conversion factor and offset

$\text{hp}_{\text{compressor}}$ = compressor motor nominal

DEEMED O&M COST ADJUSTMENTS

N/A

⁵⁵⁰ Conversion factor and offset based on a linear regression analysis of the relationship between air compressor motor nominal horsepower and incremental cost. Several Vermont vendors were surveyed to determine the cost of equipment. See "Compressed Air Analysis.xls" and "Compiled Data ReQuest Results.xls" for incremental cost details.

LOADSHAPE

Loadshape C35 - Industrial Process

COINCIDENCE FACTOR

The coincidence factor equals 0.95

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWh = 0.9 \times hp_{\text{compressor}} \times \text{HOURS} \times (CF_b - CF_e)$$

Where:

ΔkWh = gross customer annual kWh savings for the measure

$hp_{\text{compressor}}$ = compressor motor nominal hp

0.9^{551} = compressor motor nominal hp to full load kW conversion factor

HOURS = compressor total hours of operation below depending on shift

Shift	Hours
Single shift (8/5)	1976 hours 7 AM – 3 PM, weekdays, minus some holidays and scheduled down time
2-shift (16/5)	3952 hours 7AM – 11 PM, weekdays, minus some holidays and scheduled down time
3-shift (24/5)	5928 hours 24 hours per day, weekdays, minus some holidays and scheduled down time
4-shift (24/7)	8320 hours 24 hours per day, 7 days a week minus some holidays and scheduled down time

CF_b = baseline compressor factor⁵⁵²

⁵⁵¹ Conversion factor based on a linear regression analysis of the relationship between air compressor motor nominal horsepower and full load kW from power measurements of 72 compressors at 50 facilities on Long Island. See "BHP Weighted Compressed Air Load Profiles v2.xls".

⁵⁵² Compressor factors were developed using DOE part load data for different compressor control types as well as load profiles from 50 facilities employing air compressors less than or equal to 40 hp. "See "BHP Weighted Compressed Air Load Profiles.xls" for source data and calculations (The "variable speed drive" compressor factor

=0.890

CF_e = efficient compressor⁵⁵³

=0.705

EXAMPLE

For example a VFD compressor with 10 HP operating in a 1 shift facility would save

$$\Delta kWh = 0.9 \times 10 \times 1976 \times (0.890 - 0.705)$$

$$= 3290 \text{ kWh}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh / \text{HOURS} * CF$$

EXAMPLE

For example a VFD compressor with 10 HP operating in a 1 shift facility would save

$$\Delta kW = 3290 / 1976 * .95$$

$$= 1.58 \text{ kW}$$

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-MSC-VSDA-V01-120601

has been adjusted up from the 0.675 presented in the analysis to 0.705 to account for the additional power draw of the VSD).

⁵⁵³ Ibid.

4.7.2 Compressed Air Low Pressure Drop Filters

DESCRIPTION

Low pressure drop filters remove solids and aerosols from compressed air systems with a longer life and lower pressure drop than standard coalescing filters, resulting in better efficiencies.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified

DEFINITION OF EFFICIENT EQUIPMENT

The efficient condition is a low pressure drop filter with pressure drop not exceeding 1 psid when new and 3 psid at element change.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is a standard coalescing filter with a pressure drop of 3 psid when new and 5 or more at element change

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

5 years

DEEMED MEASURE COST

The incremental cost for this measure is estimated to be \$1000 Incremental cost per filter⁵⁵⁴

LOADSHAPE

Loadshape C35 - Industrial Process

COINCIDENCE FACTOR

The coincidence factor equals 0.95

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta \text{kWh} = (\text{kW}_{\text{typical}} \times \Delta P \times SF \times \text{Hours} / \text{HP}_{\text{typical}}) \times \text{HP}_{\text{real}}$$

Where:

$\text{kW}_{\text{typical}}$ = Adjusted compressor power (kW) based on typical compressor loading and operating profile.

⁵⁵⁴ Incremental cost research found in LPDF Costs. xlsx

Use actual compressor control type if known:

Compressor kW_{typical}

Control Type	kW _{typical} ⁵⁵⁵
Reciprocating - On/off Control	70.2
Reciprocating - Load/Unload	74.8
Screw - Load/Unload	82.3
Screw - Inlet Modulation	82.5
Screw - Inlet Modulation w/ Unloading	82.5
Screw - Variable Displacement	73.2
Screw - VFD	70.8

= If the actual compressor control type is not known, then use a weighted average based on the following market assumptions:

Control Type	Share %	kW _{typical} ⁵⁵⁶
Market share estimation for load/unload control compressors	40%	74.8
Market share estimation for modulation w/unloading control compressors	40%	82.5
Market share estimation for variable displacement control compressors	20%	73.2
Weighted Average		77.6

ΔP = Reduced filter loss (psi) = 2 psi⁵⁵⁷

SF = 1% reduction in power per 2 psi reduction in system pressure is equal to 0.5% reduction per 1 psi, or a Savings Factor of 0.005⁵⁵⁸

Hours = depending on shifts

Single shift (8/5) – 1976 hours (7 AM – 3 PM, weekdays, minus some holidays and scheduled down time) + 500 hrs maintenance = 2476 hrs

2-shift (16/5) – 3952 hours (7AM – 11 PM, weekdays, minus some holidays and scheduled down time) + 500 hrs maintenance = 4452 hrs

⁵⁵⁵ See "Industrial System Standard Deemed Saving Analysis.xls"

⁵⁵⁶ See "Industrial System Standard Deemed Saving Analysis.xls"

⁵⁵⁷ Assumed pressure will be reduced from a roughly 3 psi pressure drop through a filter to less than 1 psi, for a 2 psi savings

⁵⁵⁸ "Optimizing pneumatic systems for extra savings," 10, 2010, <http://www.compressedairchallenge.org/library/articles/2010-10-CABP.pdf>

3-shift (24/5) – 5928 hours (24 hours per day, weekdays, minus some holidays and scheduled down time) + 500 hrs maintenance = 6428 hrs

4-shift (24/7) – 8320 hours (24 hours per day, 7 days a week minus some holidays and scheduled down time)

HP_{typical} = Nominal HP for typical compressor = 100 hp⁵⁵⁹

HP_{real} = Total HP of real compressors distributing air through filter. This should include the total horsepower of the compressors that normally run through the filter, but not backup compressors

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh / \text{HOURS} * CF$$

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-MSC-CALPDF-V01-140601

⁵⁵⁹ Industrial System Standard Deemed Saving Analysis.xls

4.7.3 Compressed Air No-Loss Condensate Drains

DESCRIPTION

No-loss condensate drains remove condensate as needed without venting compressed air, resulting in less air demand and consequently better efficiency. Replacement or upgrades of existing no-loss drains are not eligible for the incentive.

This measure was developed to be applicable to the following program types: RF. If applied to other program types, the measure savings should be verified

DEFINITION OF EFFICIENT EQUIPMENT

The efficient condition is installation of no-loss condensate drains.

DEFINITION OF BASELINE EQUIPMENT

The baseline condition is installation of standard condensate drains (open valve, timer, or both)

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

10 years

DEEMED MEASURE COST

\$700 per drain ⁵⁶⁰

LOADSHAPE

Loadshape C35 - Industrial Process

COINCIDENCE FACTOR

The coincidence factor equals 0.95

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta \text{kWh} = \text{CFM}_{\text{reduced}} \times \text{kW}_{\text{CFM}} \times \text{Hours}$$

Where:

⁵⁶⁰ Based on empirical project data from ComEd Comprehensive Compressed Air Study program and VEIC review of pricing data found in CAS Cost Data.xls

$$CFM_{\text{reduced}} = \text{Reduced air consumption (CFM) per drain} = 3 \text{ CFM}^{561}$$

kW_{CFM} = System power reduction per reduced air demand (kw/CFM) depending on the type of compressor control:

System Power Reduction per Reduced Air Demand⁵⁶²

Control Type	kW / CFM
Reciprocating - On/off Control	0.184
Reciprocating - Load/Unload	0.136
Screw - Load/Unload	0.152
Screw - Inlet Modulation	0.055
Screw - Inlet Modulation w/ Unloading	0.055
Screw - Variable Displacement	0.153
Screw - VFD	0.178

Or if compressor control type is unknown, then a weighted average based on market share can be used:

Control Type	Share %	kW / CFM
Market share estimation for load/unload control compressors	40%	0.136
Market share estimation for modulation w/unloading control compressors	40%	0.055
Market share estimation for variable displacement control compressors	20%	0.153
Weighted Average		0.107

$$\text{Hours} = \text{Compressed air system pressurized hours} = 6136 \text{ hours}^{563}$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = \Delta kWh / \text{HOURS} * CF$$

NATURAL GAS ENERGY SAVINGS

N/A

⁵⁶¹ Reduced CFM consumption is based on an a timer drain opening for 10 seconds every 300 seconds as the baseline. See "Industrial System Standard Deemed Saving Analysis.xls"

⁵⁶² Calculated based on the type of compressor control. This assumes the compressor will be between 40% and 100% capacity before and after the changes to the system demand. See "Industrial System Standard Deemed Saving Analysis.xls"

⁵⁶³ US DOE, Evaluation of the Compressed Air Challenge® Training Program, Page 19

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

MEASURE CODE: CI-MSC-CANLCD-V01-140601