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[312]	Screw based bulb Annual Operating hours[313]	WHFe[314]	CF[315]	WHFd[316]	IFTherms[317]
Office	4,439	3,088	1.25	0.66	1.30	0.016
Grocery	5,802	3,650	1.43	0.69	1.52	0.012
Healthcare Clinic	5,095	4,207	1.34	0.75	1.57	0.008
Hospital	6,038	4,207	1.35	0.75	1.69	0.011
Heavy Industry	5,041	2,629	1.03	0.89	1.06	0.008
Light Industry	5,360	2,629	1.03	0.92	1.06	0.008
Hotel/Motel Common Areas	5,311	4,542	1.15	0.21	1.51	0.022
Hotel/Motel Guest Rooms	777	777	1.15	0.21	1.51	0.022
Hotel/Motel Guest Rooms with electric heat	777	777	0.69	0.21	0.09	0.00
High School/Middle School	4,311	2,327	1.23	0.22	0.74	0.017

[312]Fixtures hours of use are primarily derived from the default PY4 values developed for ComEd based on DEER 2005, DEER 2008, FY1 and FY2 evaluation results. Lighting introwp.doc. Values for office, grocery, light industry, restaurant, retail/service and warehouse are an average of the PY4 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.

[313]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.

[314]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.

[315]Waste Heat Factor for Demand is developed using EQuest models consistent with methodology for Waste Heat Factor for Energy.

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

[317]Hotel/Motel guest rooms are presented with either electric heat or gas heat; values chosen should match the fuel type in the space.

Building Type	Fixture Annual Operating Hours[318]	Screw based bulb Annual Operating hours[319]	WHFe[320]	CF[321]	WHFd[322]	IFTherms[323]
Elementary School	2,422	2,118	1.21	0.22	1.33	0.019
Restaurant	3,673	4,784	1.34	0.80	1.65	0.023
Retail/Service	4,719	2,935	1.24	0.83	1.44	0.024
College/University	3,540	2,588	1.14	0.56	1.50	0.021
Warehouse	4,746	4,293	1.16	0.70	1.17	0.015
Garage	3,540	3,540	1.00	1.00	1.00	0.000
Garage, 24/7 lighting[324]	8,766	8,766	1.00	1.00	1.00	0.000
Exterior	4,903	4,903	1.00	0.00	1.00	0.000
Multi-family Common Areas	5,950	5,950	1.34	0.75	1.57	0.015
Miscellaneous	4,576	3,198	1.24	0.66	1.46	0.000
Uncooled Building	Varies	varies	1.00	varies	varies	varies
Refrigerated Cases	5,802	n/a	1.29	0.69	1.29	0
Freezer Cases	5,802	n/a	1.5	0.69	1.5	0

[318]Fixtures hours of use are primarily derived from the default PY4 values developed for ComEd based on DEER 2005, DEER 2008, FY1 and FY2 evaluation results. Lighting introwp.doc. Values for office, grocery, light industry, restaurant, retail/service and warehouse are an average of the PY4 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.

[319]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.

[320]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.

[321]Waste Heat Factor for Demand is developed using EQuest models consistent with methodology for Waste Heat Factor for Energy.

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

[323]Hotel/Motel guest rooms are presented with either electric heat or gas heat; values chosen should match the fuel type in the space.

[324] Use of this value requires documentation that the lighting is required to be on 24 hours a day,7 days a week for 365.25 days per year.

4.5.1 Commercial Standard CFL

DESCRIPTION

A low wattage ENERGY STAR qualified compact fluorescent screw-in bulb (CFL) is installed in place of an incandescent screw-in bulb. This characterization assumes that the CFL is installed in a commercial location. If the implementation strategy means that the final installation location of the bulb is not known, deemed assumptions are provided. If however it is known, the values are dependent on the building type.

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

To account for these new standards and the expected delay in clearing retail inventory, the first year annual savings for this measure is reduced for 100W equivalent bulbs in June 2012, for 75W equivalent bulbs in June 2013 and for 60 and 40W equivalent bulbs in June 2014.

In addition, since during the lifetime of a CFL, the baseline bulb will be replaced multiple times, the annual savings claim must also be reduced within the life of the measure. For example, for 60W equivalent bulbs installed in 2012, the full savings (as calculated below in the Algorithm) should be claimed for the first two years, but a reduced annual savings based on the EISA-compliant baseline should be claimed for the remainder of the measure life. The appropriate adjustment factors are provided in the 'Mid Life Baseline Adjustment' section below.

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 a standard incandescent light bulb, up until when EISA regulations dictate higher efficiency baseline bulbs. A 100W baseline bulb becomes a 72W bulb in June 2012, a 75W bulb becomes 53W in June 2012 and 60W and 40W bulbs become 43W and 29W respectively in June 2014 Annual savings are reduced to account for this baseline shift within the life of a measure and the measure life is reduced to account for the baseline replacements becoming equivalent to a current day CFL by June 2020.

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 hours[325]) 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.

DEEMED MEASURE COST

The incremental capital cost assumption for all bulbs is $1.90, from June 2012 – May 2013, $1.80 from June 2013 – May 2014 and $1.50 from June 2014 – May 2015[326].

DEEMED O&M COST ADJUSTMENTS

The Net Present Value of the baseline replacement costs for each CFL lumen range and installation year (2012 - 2016) are presented below[327]:

Lumen Range	NPV of baseline replacement costs		
	June 2012 - May 2013	June 2013 - May 2014	June 2014 - May 2015
1490-2600	$11.81	$11.81	$11.81
1050-1489	$8.60	$11.81	$11.81
750-1049	$4.68	$8.60	$11.81
310-749	$4.68	$8.60	$11.81

The annual levelized baseline replacement costs using the statewide real discount rate of 5.23% are presented below:

CFL wattage	Levelized annual replacement cost savings		
	June 2012 - May 2013	June 2013 - May 2014	June 2014 - May 2015
1490-2600	$5.86	$5.86	$5.86
1050-1489	$4.26	$5.86	$5.86
750-1049	$2.32	$4.26	$5.86
310-749	$2.32	$4.26	$5.86

Note incandescent bulbs in lumen range 2601 – 3300 are exempt from EISA. For these bulbs there is no baseline shift and so the assumption is a baseline replacement cost of $0.50 every 0.2 year (1000 hr rated life/4589 run hours).

LOADSHAPE

Loadshape C06 - Commercial Indoor Lighting

[325] 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.
[326] Based on Northeast Regional Residential Lighting Strategy (RLS) report, prepared by EFG, D&R International, Ecova and Optimal Energy, applying sales weighting and phase-in of EISA regulations. Assumption is $2.50 for CFL over three years and $0.6 for baseline in 2012, $0.70 in 2013 and $1.00 in 2014 as more expensive EISA qualified bulbs become baseline.
[327] Calculation is based on average hours of use assumption, see 'C&I Standard CFL O&M calc.xls' for more details.

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.

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

ΔkWh =((WattsBase-WattsEE)/1000) * ISR * Hours * WHFe

Where:

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

Minimum Lumens	Maximum Lumens	Incandescent Equivalent Pre-EISA 2007 (WattsBase)	Incandescent Equivalent Post-EISA 2007 (WattsBase)	Effective date from which Post – EISA 2007 assumption should be used
2601	3300	150	150	N/A 2600+ lumen bulbs are exempt from EISA.
1490	2600	100	72	June 2012
1050	1489	75	53	June 2013
750	1049	60	43	June 2014
310	749	40	29	June 2014

WattsEE = Actual wattage of CFL purchased or installed

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

=100%[328] 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:

Weigted Average 1st year In Service Rate (ISR)	2nd year Installations	3rd year Installations	Final Lifetime In Service Rate
69.5%[329]	15.4%	13.1%	98.0%[330]

Hours = Average hours of use per year are provided in Reference Table in Section 6.5,

[328] 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.

[329] 1st year in service rate is based upon review of PY1-3 evaluations from ComEd and Ameren (see 'IL RES Lighting ISR.xls' for more information. The average first year ISR for each utility was calculated weighted by the number of bulbs in the each year's survey. This was then weighted by annual sales to give a statewide assumption. Note these evaluations did not look at C&I specific installations but until a more appropriate C&I evaluation is performed, the Residential assumptions are applied.

[330] 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.

Screw based bulb annual operating hours, for each building type[331]. 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 6.5. If unknown, use the Miscellaneous value.

Mid Life Baseline Adjustment

During the lifetime of a CFL, a baseline incandescent bulb would need to be replaced multiple times. Since the baseline bulb changes over time (except for 2600+ lumen bulbs) the annual savings claim must be reduced within the life of the measure to account for this baseline shift.

For example, for 60W equivalent bulbs installed in 2012, the full savings (as calculated above in the Algorithm) should be claimed for the first two years, but a reduced annual savings claimed for the remainder of the measure life. The appropriate adjustment factors are provided below.

Lumen Range	Pre EISA WattsBase	Post EISA WattsBase	CFL Equivalent	Delta Watts Before EISA	Delta Watts After EISA	Mid Life Adjustment	Adjustment made from date
2601-3300	150	150	42	108	108	-	-
1490-2600	100	72	25	75	47	63%	N/A (2012 is already post EISA)
1050-1489	75	53	20	55	33	60%	June, 2013
750-1049	60	43	14	46	29	63%	June, 2014
310-749	40	29	11	29	18	62%	June, 2014

For example, a 20W standard CFL, 1200 lumen is installed in an office in 2012 and sign off form provided:

ΔkWH = ((75-20)/1000)*1.0*3088*1.25

= 212 kWh

This value should be claimed in June 2012 – May 2013, but from June 2013 on savings for that same bulb should be reduced to (212 * 0.6 =) 127 kWh for the remainder of the measure life. Note these adjustments should be applied to kW and fuel impacts.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW= ((WattsBase-WattsEE)/1000) * ISR * WHFd * 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 6.5. If unknown, use the Miscellaneous value..

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

CF = Summer Peak Coincidence Factor for measure is provided in the Reference Table in Section 6.5. If unknown, use the Miscellaneous value..

Other factors as defined above

For example, a 20W standard CFL, 1200 lumen is installed in an office in 2012 and sign off form provided:

ΔkW = ((75-20)/1000)*1.0*1.3*0.66

= 0.047kW

NATURAL GAS ENERGY SAVINGS

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

ΔTherms[332] = (((WattsBase-WattsEE)/1000) * ISR * Hours *- IFTherms

Where:

IFTherms = Lighting-HVAC Interation Factor for gas heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficent lighting. Values are provided in the Reference Table in Section 6.5. If unknown, use the Miscellaneous value.

Other factors as defined above

For example, a 20W standard CFL, 1200 lumen is installed in an office in 2012 and sign off form provided:

ΔTherms = (((75-20)/1000)* 1.0*3088*-0.016

= - 2.7 Therms

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

In order to account for the shift in baseline due to the Energy Independence and Security Act of 2007, an equivalent annual levelized baseline replacement cost over the lifetime of the CFL is calculated (see C&I Standard CFL O&M calc.xls). The key assumptions used in this calculation are documented below[333]:

	Standard Incandescent	Efficient Incandescent	CFL
Replacement Cost	$0.50	$1.50	$2.50

[332]Negative value because this is an increase in heating consumption due to the efficient lighting.
[333]Calculation is based on average hours of use assumption.

Component Rated Life (hrs)	1000	1000[334]	10,000

The Net Present Value of the baseline replacement costs for each CFL lumen range and installation year (2012 - 2016) are presented below[335]:

Lumen Range	NPV of baseline replacement costs		
	June 2012 - May 2013	June 2013 - May 2014	June 2014 - May 2015
1490-2600	$12.86	$12.86	$12.86
1050-1489	$9.36	$12.86	$12.86
750-1049	$5.10	$9.36	$12.86
310-749	$5.10	$9.36	$12.86

The annual levelized baseline replacement costs using the statewide real discount rate of 5.23% are presented below:

CFL wattage	Levelized annual replacement cost savings		
	June 2012 - May 2013	June 2013 - May 2014	June 2014 - May 2015
1490-2600	$6.38	$6.38	$6.38
1050-1489	$4.64	$6.38	$6.38
750-1049	$2.53	$4.64	$6.38
310-749	$2.53	$4.64	$6.38

Note incandescent bulbs in lumen range 2601 – 3300 are exempt from EISA. For these bulbs there is no baseline shift and so the assumption is a baseline replacement cost of $0.50 every 0.2 year (1000 hr rated life/4576 run hours).

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

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[334] 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.

[335] Calculation is based on average hours of use assumption, see ‘C&I Standard CFL O&M calc.xls’ for more details.

4.5.2 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.

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) will require 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. To account for this legislation, a mid life adjustment is calculated for Standard Omnidirectional screw based bulbs whose baseline assumes incandescent lamps.

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.

Deemed O&M Cost Adjustments

Refer to reference table “LED component Cost & Lifetime.”

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.

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:

Omnidirectional Lamps - ENERGY STAR Minimum Luminous Efficacy = 50Lm/W for <10W lamps and 55Lm/W for >=10W lamps.

Nominal wattage of lamp to be replaced ($Watts_{base}$)	Minimum initial light output of LED lamp (lumens)	Post EISA 2012-2014 Incandescent wattage	Post EISA 2020 requirement (45Lm/W)	LED Wattage ($Watts_{EE}$)	Delta Watts (pre EISA)	Delta Watts (post EISA 2012-2014)	Effective date for post EISA 2012-2014 assumption	Delta Watts (post EISA 2020)
25	200	25	25	4.0	21.0	21.0	Exempt	21.0
35	325	29	7.2	6.5	28.5	22.5	June 2014	0.7
40	450	29	10	9.0	31.0	20.0	June 2014	1.0
60	800	43	17.8	14.5	45.5	28.5	June 2014	3.3
75	1,100	53	24.4	20.0	55.0	33.0	June 2013	4.4
100	1,600	72	35.6	29.1	70.9	42.9	June 2012	6.5
125	2,000	72	44.4	36.4	88.6	35.6	June 2012	8.0
150	2,600	150	150	47.3	102.7	102.7	Exempt	102.7

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

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

Directional 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).

Nominal wattage of lamp to be replaced (Wattsbase)	Minimum initial light output of LED lamp (lumens)	LED Wattage (WattsEE)	Delta Watts
25	250	6.25	18.75
35	350	8.75	26.25
40	400	10.0	30.0
60	600	15.0	45.0
75	750	18.75	56.25
100	1000	25.0	75.0
125	1250	31.25	93.75
150	1500	37.5	112.5

Directional lamps are exempt from EISA regulations.

Hours = Average hours of use per year are provided in the Reference Table in Section 6.5, 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 Referecne Table in Section 6.5. If unknown, use the Miscellaneous value.

ISR = In service Rate -the percentage of units rebated that actually get installed. Use 100% unless an evaluation shows a lesser value.

Mid Life Baseline Adjustment

During the lifetime of a standard Omnidirectional LED, the baseline incandescent bulb would need to be replaced multiple times. Since the baseline bulb changes over time (except for 2600+ lumen bulbs) the annual savings claim must be reduced within the life of the measure to account for this baseline shift.

For example, for 60W equivalent bulbs installed in 2012, the full savings (as calculated above in the Algorithm) should be claimed for the first two years, but a reduced annual savings (calculated energy savings above multipled by the adjustment factor in the table below) claimed for the remainder of the measure life.

Omnidirectional Lamps

Nominal wattage of lamp to be replaced ($Watts_{base}$)	Minimum initial light output of LED lamp (lumens)	Delta Watts (pre EISA)	Delta Watts (post EISA 2012-2014)	Mid Life adjustment 1 from first year savings	Adjustment made from date	Delta Watts (post EISA 2020)	Mid Life adjustment 2 (made from June 2020) from first year savings
25	200	21.0	21.0	Exempt	Exempt	21.0	Exempt
35	325	28.5	22.5	78.9%	June 2014	0.7	2.5%
40	450	31.0	20.0	64.5%	June 2014	1.0	3.2%
60	800	45.5	27.6	60.7%	June 2014	3.3	7.3%
75	1,100	55.0	33.0	60.0%	June 2013	4.4	8.0%
100	1,600	70.9	42.9	60.5%	June 2012	6.5	9.2%
125	2,000	88.6	35.6	40.2%	June 2012	8.0	9.0%
150	2,600	102.7	102.7	Exempt	Exempt	102.7	Exempt

For example, a 9W LED lamp, 450 lumens, is installed in an office in 2012:

$$\Delta kWH = ((40-29/1000)*1.0*3088*1.25$$

$$= 42.5 \text{ kWh}$$

This value should be claimed for two years, i.e. June 2012 – May 2014, but from June 2014 on savings for that same bulb should be reduced to (42.5 * 0.645 =) 27.4 kWh for the remainder of the measure life. Note these adjustments should be applied to kW and fuel impacts.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = ((Watts_{base}-Watts_{EE})/1000) * ISR * WHF_d * CF$$

Where:

WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting in cooled buildings is provided in Referecne Table in Section 6.5. If unknown, use the Miscellaneous value.

CF = Summer Peak Coincidence Factor for measure is provided in the Referecne Table in Section 6.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in an office in 2012and sign off form provided:

ΔkW = ((40-29/1000)* 1.0*1.3*0.66

= - 0.52 kW

NATURAL GAS ENERGY SAVINGS

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

Δtherms = (((WattsBase-WattsEE)/1000) * ISR * Hours *- 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 6.5. If unknown, use the Miscellaneous value.

For example, For example, a 9W LED lamp, 450 lumens, is installed in an office in 2012 and sign off form provided:

ΔTherms = ((40-29/1000)*1.0*3088* -0.016

= - 0.54 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 below[336].

[336] See “LED reference tables.xls” for breakdown of component cost assumptions.

Omnidirectional Lamps:

In order to account for the shift in baseline due to the Energy Independence and Security Act of 2007, an equivalent annual levelized baseline replacement cost over the lifetime of the LED bulb (assumed to be 25,000/4576 = 6.46 years) is calculated (see “C&I OmniDirectional LED O&M Calc.xls”). The key assumptions used in this calculation are documented below:

	Standard Incandescent	Efficient Incandescent	CFL
Replacement Cost	$0.50	$1.50	$2.50
Component Rated Life (hrs)	1000	1000[337]	10,000

The Net Present Value of the baseline replacement costs for each lumen range and installation year (2012 -2016) are presented below:

	NPV of baseline replacement costs		
Lumen Range	June 2012 - May 2013	June 2013 - May 2014	June 2014 - May 2015
1490-2600	$32.23	$32.23	$26.78
1050-1489	$28.66	$32.23	$26.78
750-1049	$24.31	$28.66	$26.78
310-749	$24.31	$28.66	$26.78

The annual levelized baseline replacement costs using the statewide real discount rate of 5.23% are presented below:

	Levelized annual replacement cost savings		
CFL wattage	June 2012 - May 2013	June 2013 - May 2014	June 2014 - May 2015
1490-2600	$6.94	$6.94	$5.76
1050-1489	$6.17	$6.94	$5.76
750-1049	$5.23	$6.17	$5.76
310-749	$5.23	$6.17	$5.76

Note incandescent bulbs in lumen range <310 and >2600 are exempt from EISA. For these bulbs there is no baseline shift and so the assumption is a baseline replacement cost of $0.50 every 0.2 year (1000 hr rated life/4576 run hours).

[337] 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 Assumptions[338]

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	$0.50 ($1.50, $2.50)	$29.5 ($28.50, $27.50)	25,000
LED Screw and Pin-based Bulbs, Omnidirectional, >= 10W					$40.00	$0.50 ($1.50, $2.50)	$29.5 ($28.50, $27.50)	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	
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	36.2	2008-2010 EVT Historical Data of 21	50,000		$25.00	

[338] Data is based on Efficiency Vermont derived cost and actual installed wattage information.

		Fixtures		Measures					
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[339] 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		
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		

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

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

LED Component Costs & Lifetime[340]

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% CMH PAR38	12,000	$62.92	40,000	$110.00	90% Halogen PAR38	2,500	$12.67
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

[340] 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.

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 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 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 Lights, < 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 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-V01-120601

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.

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)
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.	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. 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 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)
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).. 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. High bay fixtures must have fixture efficiencies of 85% or greater. 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://www.cee1.org/com/com-lt/com-lt-main.php3). 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.	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). 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. High bay fixtures will have fixture efficiencies of 85% or greater. 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://www.cee1.org/com/com-lt/com-lt-main.php3). 2', 3' and 8' lamps must meet the wattage requirements specified in the RWT8 new and baseline assumptions table.

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 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 efficency troffer.	The baseline is the existing system. For T12 systems, the baseline becomes standard T8 in 2016 regardless of the equipment on site due to the phase in of EISA standards.

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)
Fixture lifetime is 15 years[341]. 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. 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.[342] .	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.

[341] 15 years from GDS Measure Life Report, June 2007
[342] ibid

DEEMED MEASURE COST AND O&M COST ADJUSTMENTS

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

Time of Sale (TOS)	Retrofit (RF)
Refer to reference tables A-1: Time of Sale New and Baseline Assumptions and B-1 Time of Sale T8 Component Costs and Lifetime. For RTW8 refer to reference table A-3: RWT8 New and Baseline Assumptions and B-3 RWT8 T8 Component Costs and Lifetime.	Refer to reference tables A-2: Retrofit New and Baseline Assumptions and B-2 Retrofit HPT8 Component Costs and Lifetime. For RTW8 refer to reference table A-3: RWT8 New and Baseline Assumptions and B-3 RWT8 T8 Component Costs and Lifetime. For T12 Baseline Adjustment Factors, refer to Table C-1.

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

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

SUMMER COINCIDENT DEMAND SAVINGS

$$\Delta kW = ((Watts_{base} - Watts_{EE})/1000) * WHF_d * CF * ISR$$

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 exisitng 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 exisitng 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 6.5, 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 6.5 for each building type. If building is un-cooled, the value is 1.0.

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 6.5 for each building type. If the building is not cooled WHFd is 1.

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

=100%[343] 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:

Weigted	2^{nd} year	3^{rd} year	Final

[343]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.

Average 1st year In Service Rate (ISR)	Installations	Installations	Lifetime In Service Rate
69.5%[344]	15.4%	13.1%	98.0%[345]

CF= Summer Peak Coincidence Factor for measure is selected from the Reference Table in Section 6.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

NATURAL GAS ENERGY SAVINGS

ΔTherms[346] = (((WattsBase-WattsEE)/1000) * ISR * Hours *- 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 6.5 for each building type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

[344] 1st year in service rate is based upon review of PY1-3 evaluations from ComEd and Ameren (see 'IL RES Lighting ISR.xls' for more information. The average first year ISR for each utility was calculated weighted by the number of bulbs in the each year's survey. This was then weighted by annual sales to give a statewide assumption. Note these evaluations did not look at C&I specific installations but until a more appropriate C&I evaluation is performed, the Residential assumptions are applied.

[345] 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.

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

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

A-1: Time of Sale: HPT8 New and Baseline Assumptions[347]

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

[347] 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 Assumptions[348] (Note see definiton 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

348 Ibid.

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 Lifetime[349]

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

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

B-2: T8 Retrofit Component Costs and Lifetime[350]

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/ballst 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	3-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 Lifetime[351]

[350] 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

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

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

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'.[352]

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-V01-120601

[352] Adapted from EVT Technical Resource Manual, 2012-75, page 85.

4.5.4 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.

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)
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.	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.

Definition of Efficient Equipment

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

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.	The baseline is the existing system. For T12 systems, the baseline becomes standard T8 in 2016. Retrofits to T12 systems installed before 2016 have a baseline adjustment applied in 2016 for the remainder of the measure life. 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.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The deemed lifetime of the efficient equipment fixture, regardless of program type is Fixture lifetime is 15 years[353].

DEEMED MEASURE COST AND O&M COST ADJUSTMENTS

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

Time of Sale (TOS)	Retrofit (RF)
Refer to reference tables A-1: Time of Sale New and Baseline Assumptions and B-1: Time of Sale T5 Component Costs and Lifetime.	Refer to reference tables A-2: Retrofit New and Baseline Assumptions and B-2 Retrofit T5 Component Costs and Life.

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

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

SUMMER COINCIDENT DEMAND SAVINGS

$$\Delta kW = ((Watts_{base} - Watts_{EE})/1000) * WHF_d * CF * ISR$$

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353 15 years from GDS Measure Life Report, June 2007

Where:

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

$Watts_{base}$ = 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 exisitng 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, of a custom value can be entered if the configurations in the tables is not representative of the exisitng 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 6.5, 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 6.5 for each building type. If building is un-cooled, the value is 1.0.

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 6.5 for each building type. If the building is not cooled WHFd is 1.

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

=100%[354] 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:

Weigted	2nd year	3rd year	Final

[354]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.

Average 1st year In Service Rate (ISR)	Installations	Installations	Lifetime In Service Rate
69.5%[355]	15.4%	13.1%	98.0%[356]

CF= Summer Peak Coincidence Factor for measure is selected from the Reference Table in Section 6.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66.

NATURAL GAS ENERGY SAVINGS

ΔTherms[357] = (((WattsBase-WattsEE)/1000) * ISR * Hours *- 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

[355] 1st year in service rate is based upon review of PY1-3 evaluations from ComEd and Ameren (see 'IL RES Lighting ISR.xls' for more information. The average first year ISR for each utility was calculated weighted by the number of bulbs in the each year's survey. This was then weighted by annual sales to give a statewide assumption. Note these evaluations did not look at C&I specific installations but until a more appropriate C&I evaluation is performed, the Residential assumptions are applied.

[356] 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.

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

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

A-1: Time of Sale: T5 New and Baseline Assumptions[358]

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

[358] 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 Assumptions[359]

EE Measure Description	EE Cost	$Watts_{EE}$
3-Lamp T5 High-Bay	$ 200	180
4-Lamp T5 High-Bay	$ 225	240
6-Lamp T5 High-Bay	$ 250	360
1-Lamp T5 Troffer/Wrap	$ 100	32
2-Lamp T5 Troffer/Wrap	$ 100	64
1-Lamp T5 Industrial/Strip	$ 70	32
2-Lamp T5 Industrial/Strip	$ 70	64
3-Lamp T5 Industrial/Strip	$ 70	96
4-Lamp T5 Industrial/Strip	$ 70	128
1-Lamp T5 Indirect	$ 175	32
2-Lamp T5 Indirect	$ 175	64

Baseline Description	$Watts_{BASE}$
200 Watt Pulse Start Metal-Halide	232
250 Watt Metal-Halide	295
320 Watt Pulse Start Metal-Halide	350
400 Watt Metal halide	455
400 Watt Pulse Start Metal-halide	476
1-Lamp F34T12 w/ EEMag Ballast	40
2-Lamp F34T12 w/ EEMag Ballast	68
3-Lamp F34T12 w/ EEMag Ballast	110
4-Lamp F34T12 w/ EEMag Ballast	139
1-Lamp F40T12 w/ EEMag Ballast	48
2-Lamp F40T12 w/ EEMag Ballast	82
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

[359] Ibid.

B-1: Time of Sale T5 Component Costs and Lifetime[360]

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

[360] 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 Lifetime[361]

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

361 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-V01-120601

4.5.5 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.

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 years[362].

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[363]
Full cost mounted occupancy sensor	$66[364]
Full cost of fixture-mounted occupancy sensor	$125[365]

DEEMED O&M COST ADJUSTMENTS

N/A

[362] DEER 2008
[363] Goldberg et al, State of Wisconsin, Public Service Commission of Wisconsin, Focus on Energy Evaluation Business programs Incremental Cost Study, KEMA, October 28, 2009
[364] Ibid
[365] Efficiency Vermont TRM, October 26, 2011.

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

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

Summer Coincident Peak Demand Savings

$\Delta kW = KW_{controlled} * WHF_d * (CFbaseline - CFos)$

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[366]
Remote mounted occupancy sensor	0.587[367]
Fixture mounted sensor	0.073[368]

[366] Goldberg et al, State of Wisconsin Public Service Commission of Wisconsin, Focus on Energy Evaluation, Business Programs, Incremental Cost Study, KEMA, October 28, 2009
[367] Ibid

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 6.5, Fixture annual operating hours, for each building type if customer specific information is not collected. If unknown buidling 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[369]
Wall or Ceiling-Mounted Occupancy Sensors	41% or custom
Fixture Mounted Occupancy Sensors	30% or custom

WHF_e = Waste heat factor for energy to account for cooling energy savings from efficient lighting is provided in the Reference Table in Section 6.5 for each building type. If building is un-cooled, the value is 1.0.

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 6.5. If the building is un-cooled WHFd is 1.

CFbaseline = Baseline Summer Peak Coincidence Factor for the lighting system without Occupancy Sensors installed selected from the Reference Table in Section 6.5 for each building type. If the building type is unknown, use the Miscellaneous value of 0.66

CFos = Retrofit Summer Peak Coincidence Factor the lighting system with Occupancy Sensors installed is 0.15 regardless of building type.[370]

NATURAL GAS ENERGY SAVINGS

Δtherms = ΔKWH* - 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 6.5 by buidling type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

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368 Efficiency Vermont TRM 2/19/2010

369 Kuiken, Tammy eta 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.

370 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.

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

4.5.6 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 as defined in IECC 2009 or the Space-by-Space Method defined in ASHAE 90.1 2007 can be used for calculating the Interior Lighting Power Density[371]. 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 2009, 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 2009, the State of Illinois Energy Code by building type or ASHRAE 90.1 2007 Space – by- Space requirements.

DEEMED CALCULATION FOR THIS MEASURE

Annual kWh Savings = ΔkWh = (WSFbase-WSFeffic)/1000* SF* Hours * WHF_e

Summer Coincident Peak kW Savings = ΔkW = (WSFbase-WSFeffic)/1000* SF* CF * WHF_d

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected measure life is assumed to be 15 years[372]

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.

DEEMED O&M COST ADJUSTMENTS

N/A

[371] 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).
[372] 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

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

SUMMER COINCIDENT PEAK DEMAND SAVINGS

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

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.[373]

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 6.5, Fixture annual

[373] IECC 2009 - Reference Code documentation for additional information.

operating hours.

WHF_e = Waste Heat Factor for Energy to account for cooling savings from efficient lighting is as provided in the Reference Table in Section 6.5 by buidling type. If building is not cooled WHF_e is 1.

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 6.5 by buidling type. If building is not cooled WHFd is 1.

CF = Summer Peak Coincidence Factor for measure is as provided in the Reference Table in Section 5.4 by buidling type. If the building type is unknown, use the Miscellaneous value of 0.66.

NATURAL GAS ENERGY SAVINGS

Δtherms = ΔKWH* - 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 provided in the Reference Table in Section 6.5 by buidling type.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

N/A

REFERENCE TABLES

Lighting Power Density Values from IECC 2009 for Interior Commercial New Construction and Substantial Renovation

Building Area Type [374]	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
Gymnasium	1.1
Healthcare – clinic	1.0

[374] IECC 2009 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.

Building Area Type [374]	Lighting Power Density (w/ft^2)
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	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail[375]	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

REFERENCE TABLES

The exterior lighting design will be based on the building location and the applicable "Lighting Zone" as defined in IECC 2009 Table 505.6.2(1) which follows.

[375] 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.

TABLE 505.6.2(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 2009 Table 505.6.2(2) which follows.

TABLE 505.6.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance may be used in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W
Tradable Surfaces (Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas may be traded.)	**Uncovered Parking Areas**				
	Parking areas and drives	0.04 W/ft²	0.06 W/ft²	0.10 W/ft²	0.13 W/ft²
	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/ft²	0.14 W/ft²	0.16 W/ft²	0.2 W/ft²
	Stairways	0.75 W/ft²	1.0 W/ft²	1.0 W/ft²	1.0 W/ft²
	Pedestrian tunnels	0.15 W/ft²	0.15 W/ft²	0.2 W/ft²	0.3 W/ft²
	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/ft²	0.25 W/ft²	0.4 W/ft²	0.4 W/ft²
	Sales Canopies				
	Free-standing and attached	0.6 W/ft²	0.6 W/ft²	0.8 W/ft²	1.0 W/ft²
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft²	0.25 W/ft²	0.5 W/ft²	0.7 W/ft²
	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/ft² for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft² for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft² 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/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² 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

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

4.5.7 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.[376] 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).

DEEMED O&M COST ADJUSTMENTS[377]

Because LEDs last much longer than incandescent bulbs, LEDs offer operation and maintenance (O&M) savings over the life of the lamps for avoided replacement lamps and the labor to install them. The following assumptions are used to calculate the O&M savings:

Incandescent bulb cost: $3 per bulb

Labor cost to replace incandescent lamp: $60 per signal

Life of incandescent bulb: 8000 hours

376 ACEEE, (1998) A Market Transformation Opportunity Assessment for LED Traffic Signals, http://www.cee1.org/gov/led/led-ace3/ace3led.pdf
377 Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010

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
Loadshape C32 - Traffic Signal - “Man” Walk Signal
Loadshape C33 - Traffic Signal - Bi-Modal Walk/Don’t Walk

COINCIDENCE FACTOR[378]

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

[378] Ibid

= see Table 'Traffic Signals Technology Equivalencies'

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:

ΔkWh = ((69 - 7) x 4818) / 1000
= 299 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = (Wbase– Weff) x CF / 1000

Where:

Wbase =The connected load of the baseline equipment

= see Table 'Traffic Signals Technology Equivalencies'

Weff =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:

ΔkW = ((69 – 7) x 0.55) / 1000

= 0.0341 kW

NATURAL GAS ENERGY SAVINGS

N/A

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

REFERENCE TABLES

Traffic Signals Technology Equivalencies[379]

Traffic Fixture Type	Fixture Size and Color	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[380]	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
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

[379] 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
[380] Technical Reference Manual for Ohio, August 6, 2010

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

4.6 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.[381]

DEEMED MEASURE COST

The deem measure cost is $156.82 for a walk-in cooler or freezer.[382]

DEEMED O&M COST ADJUSTMENTS

N/A

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

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

[381] Source: DEER 2008
[382] Ibid.

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 Cooler or Freezer Doors. Savings are averaged across all California climate zones and vintages[383].

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

[383] 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 years [384].

DEEMED MEASURE COST

The actual measure installation cost should be used (including material and labor), but the following can be assumed for analysis purposes[385]:

Refrigerated Vending Machine and Glass Front Cooler: $180.00

Non-Refrigerated Vending Machine: $80.00

DEEMED O&M COST ADJUSTMENTS

N/A

[384] Measure Life Study, prepared for the Massachusetts Joint Utilities, Energy & Resource Solutions, November 2005.
[385] ComEd workpapers, 8—15-11.pdf

LOADSHAPE

Loadshape C52 - Beverage and Snack Machine Controls

COINCIDENCE FACTOR

The summer peak coincidence factor for this measure is assumed to be 0[386].

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

ΔkWh = 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[387]
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)[388]
Refrigerated Beverage Vending Machines	46%
Non-Refrigerated Snack Vending Machines	46%
Glass Front Refrigerated Coolers	30%

386 Assumed that the peak period is coincident with periods of high traffic diminishing the demand reduction potential of occupancy based controls.
387 USA Technologies Energy Management Product Sheets, July 2006; cited September 2009. <http:// http://www.usatech.com/energy_management/energy_productsheets.php>
388 Ibid.

EXAMPLE

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

ΔkWh = WATTSbase / 1000 * HOURS * ESF

=400/1000* 8766* .46 = 1.6 kWh

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 years [389].

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 $200[390].

DEEMED O&M COST ADJUSTMENTS

N/A

LOADSHAPE

Loadshape C51 - Door Heater Control

[389] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values", California Public Utilities Commission, December 16, 2008.
[390] Efficiency Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, February, 19, 2010

COINCIDENCE FACTOR[391]

The summer peak coincidence factor for this measure is assumed to be 0%[392].

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

$$\Delta kWH = kWbase * NUMdoors * ESF * BF * 8760$$

Where:

kWbase[393] = 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[394] = 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[395] = 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.

[391] Source partial list from DEER 2008

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

[393] 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.

[394] 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.

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

[396] Energy Efficiency Supermarket Refrigeration, Wisconsin Electric Power Company, July 23, 1993

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 preperation 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

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 years[397]

DEEMED MEASURE COST

The measure cost is assumed to be $50 for a walk in cooler and walk in freezer. [398]

DEEMED O&M COST ADJUSTMENTS

N/A

LOADSHAPE

Loadshape C22 - Commercial Refrigeration

COINCIDENCE FACTOR

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

Algorithm

CALCULATION OF SAVINGS [399]

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

[397] DEER
[398] Act on Energy Commercial Technical Reference Manual No. 2010-4
[399] "Efficient Evaporator Fan Motors (Shaded Pole to ECM)," Workpaper WPSCNRRN0011. Southern California Edison Company. 2007.

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 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

	Restaurant			
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	0.0286	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

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 years[400]

Deemed Measure Cost

The incremental cost of this measure is $500[401]

Deemed O&M Cost Adjustments

N/A

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.

[400] ENERGY STAR
[401] ENERGY STAR

ELECTRIC ENERGY SAVINGS

ENERGY STAR Vending Machine Savings[402]

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

[402] 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 years[403]

DEEMED MEASURE COST

The measure cost is assumed to be $291[404]

DEEMED O&M COST ADJUSTMENTS

N/A

LOADSHAPE

Loadshape C46 - Evaporator Fan Control

COINCIDENCE FACTOR

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

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403 Source: DEER
404 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 inactive[405].

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

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

405 2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report

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 years[406].

Deemed Measure Cost

The incremental capital cost for this measure is $10.22 per square foot of door opening (includes material and labor) [407].

Deemed O&M Cost Adjustments

N/A

Loadshape

Loadshape C22 - Commercial Refrigeration

Coincidence Factor

The summer peak coincidence factor for this measure is 100%[408].

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[406] 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.
[407] 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, “Cost Values and Summary Documentation”, California Public Utilities Commission, December 16, 2008
[408] 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 SAVINGS[409]

ΔkWh = 2,974 per freezer with curtains installed

= 422 per cooler with curtains installed

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh / 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-V01-120601

[409] 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.

4.7 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 x $hp_{compressor}$) + 1446

Where:

127 and 1446[410] = compressor motor nominal hp to incremental cost conversion factor and offset

$hp_{compressor}$ = compressor motor nominal

Deemed O&M Cost Adjustments

N/A

Loadshape

Loadshape C35 - Industrial Process

[410] 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.

COINCIDENCE FACTOR

The coincidence factor equals 0.95

Algorithm

CALCULATION OF SAVINGS

ELECTRIC ENERGY SAVINGS

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

Where:

ΔkWh = gross customer annual kWh savings for the measure

$hp_{compressor}$ = compressor motor nominal hp

0.9[411] = 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 factor[412]

=0.890

CF_e = efficient compressor [413]

[411] 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".

[412] 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 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).

=0.705

EXAMPLE

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

ΔkWh = 0.9 x 10 x 1976 x (0.890 – 0.705)

= 3290 kWh

SUMMER COINCIDENT PEAK DEMAND SAVINGS

ΔkW = ΔkWh / HOURS * CF

EXAMPLE

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

ΔkW = 3290/1976*.95

= 1.58 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

[413] Ibid.