DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Lighting Efficiency (Midstream)

Description:

Customers will receive point of sale rebates at their lighting equipment distributor for qualified Lamps and Retrofit Kits.

Equations:

Electrical Demand Savings (Customer kW)	= Quantity x (Watts_Base - Watts_EE)/1000 x Cooling_kW_Savings_Factor
Electrical Energy Savings (Customer kWh)	= Quantity x (Watts_Base - Watts_EE)/1000 x Hours x Cooling_kWh_Savings_Factor
Electrical Peak Coincident Demand Savings (Customer PCkW)	= Quantity x (Watts_Base - Watts_EE)/1000 x Cooling_kW_Savings_Factor x CF
LPW_EE	= Lumens_EE / Watts_EE
Watts_Base	= Watts_EE x LPW_EE / LPW_Base
Natural Gas Savings (Dth)	= Quantity x (Watts_Base - Watts_EE)/1000 x Hours x Heating_Penalty_Factor

Applies to: LED Linear Lamps - Type A, LED PL/G based CFL Replacement lamp - Type A

Electrical Demand Savings (Customer kW)	= Quantity x (Watts_Base - Sys_Watts_EE)/1000 x Cooling_kW_Savings_Factor
Electrical Energy Savings (Customer kWh)	= Quantity x (Watts_Base - Sys_Watts_EE)/1000 x Hours x Cooling_kWh_Savings_Factor
Electrical Peak Coincident Demand Savings (Customer PCkW)	= Quantity x (Watts_Base - Sys_Watts_EE)/1000 x Cooling_kW_Savings_Factor x CF
LPW_EE	= Lumens_EE / Watts_EE
Watts_Base	= Watts_EE x LPW_EE / LPW_Base / Baseline_Equivalency_Factor / Ballast_Factor
Sys_Watts_EE	= Watts_EE / Ballast_Efficiency
Natural Gas Savings (Dth)	= Quantity x (Watts_Base - Sys_Watts_EE)/1000 x Hours x Heating_Penalty_Factor

Applies to: LED Linear Lamps - Type B & C, LED PL/G based CFL Replacement lamp - Type B, LED Screw-in Lamps - HID Replacement

Watts_Base	= Watts_EE x LPW_EE / LPW_Base / Baseline_Equivalency_Factor / Ballast_Factor

*Rest of the equations are the same as the first table

Variable ID:	Value	Description
Quantity	Vendor Input	Quantity of lamps or retrofit kits.
Measure Category	Vendor Input	Type of lamp or retrofit kit.
Watts_EE	Vendor Input	High efficiency lamp wattage. This is defined by the manufacturer and maintained and reported by the distributor.
Lumens_EE	Vendor Input	High efficiency lamp rated brightness (lumens). This is defined by the manufacturer and maintained and reported by the distributor.

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LPW_Base	Table 1	Efficacy of the baseline technology (lumens per watt).
Cooling_kW_Savings_Factor	1.24	Reduction in lighting demand results in a reduction in cooling demand, if the customer has air conditioning. The program will not have direct access to market segment information, so a deemed weighted average was created based on a three year history of downstream participation. [1, 2]
Cooling_kWh_Savings_Factor	1.09	Reduction in lighting energy results in a reduction in cooling energy, if the customer has air conditioning. The program will not have direct access to market segment information, so a deemed weighted average was created based on a three year history of downstream participation. [1, 2]
Heating_Penalty_Factor	-0.000508	Reduction in lighting energy results in an increase in heating usage, if the customer has gas heating (Dth/kWh). [2]

CF	75%	Coincidence Factor is the probability that the peak demand of the lights will coincide with peak utility system demand. The program will not have direct access to market segment information, so a deemed weighted average was created based on a three year history of downstream participation. [1, 2]
Hours	5,194	Annual operating hours. The program will not have direct access to market segment information, so a deemed weighted average based on a three year history of downstream participation was created. [1, 2]
Ballast_Factor	88%	Ballast factor is the measured ability of a fluorescent ballast to produce light from the lamp(s) it powers. In addition to the effect on light output, there is also an indirect impact on energy consumption. A normal ballast factor is assumed here. [16]
Ballast_Efficiency	85%	There is an inefficiency when an LED lamp is running off of a ballast, which adds additional wattage to the nominal lamp wattage. Ballast efficiency may also be referred to as power factor in general terms. Power factor is the fraction of power actually used by the ballast compared to the total power supplied. The ballast efficiency accounts for this inefficiency. [17]
Baseline_Equivalency_Factor	Table 2	Accounts for differences in luminaire efficiency (ratio of light emitted by the fixture to the lumen output of the lamp-ballast system alone), lumen depreciation over time, and overdesigned spaces.
Measure Life	Table ~~2~~ 3	Length of time the lighting equipment will be operational, equals the lifetime hours of the lamp divided by the deemed hours of use.
Baseline Cost	Table ~~3~~ 4	Cost of the baseline technology.
Labor Cost	Table 5	Cost of labor to install the Type B and Type C lamps. [1]
High Efficiency Cost	Vendor Input	Cost of the high efficiency technology. Costs will be collected from the equipment distributor on the product invoice.
NTG	92%	Net-to-gross factor. [3]

Assumptions:
- Midstream LED Lamps are put in on a one-for-one basis instead of lower efficiency options.
- ENERGY STAR and non - ENERGY STAR rebates available. Non-ENERGY STAR products must meet the ENERGY STAR product eligibility category definitions.

Tables:

Table 1: Baseline Lamp Efficacy based on Lamp Category [4 - 9, 14]

Measure Category	Avg. Efficacy
A Lamp rated for 310 - 749 Lumens	27.12
A Lamp rated for 750 - 1049 Lumens	36.88
A Lamp rated for 1050 - 1489 Lumens	39.45
A Lamp rated for 1490 - 2600 Lumens	37.93

General Directional (PAR, BR, R)	18.69
Multifaceted Reflector (MR16)	13.00
Decorative (B, BA, Candle, Globe)	10.45
Downlight Retrofit Kit	24.39
Fluorescent Linear Lamps	88.70
PL/G based CFL lamp	69.30
HID Screwin Lamp	83.20

Table 2: Baseline Equivalency Factor (BEF) [15]

Measure Category	BEF
LED Linear Lamps - Type A	0.70
LED Linear Lamps - Type B, C	0.87
LED PL/G based CFL Replacement Lamp	0.52
LED Screw-in Lamps, HID Replacement	0.62

Table ~~2~~ 3: Measure Lifetimes in Years [10, 12, 13]

Measure Category	Lifetime
LED Interior Lamp - A Lamp	4.12
General Directional (PAR, BR, R)	4.83
Multifaceted Reflector (MR16)	4.84
Decorative (B, BA, Candle, Globe)	3.59
Downlight Retrofit Kit	8.81
LED Linear Lamps - Type A	14.4
LED Linear Lamps - Type B	9.7
LED Linear Lamps - Type C	20.0
LED PL/G based CFL Replacement lamp	9.3
LED Screw-in Lamps, HID Replacement	9.7

Table ~~3~~ 4: Baseline Costs [11]

Measure Category	Baseline Cost
A19 60W, 750-1049 lm	$2.84
A19 100W, 1490-2600 lm	$3.48
Decorative (Candle/Globe)	$1.85
BR30	$3.34
BR40	$7.48
MR16	$8.65
PAR16	$12.32
PAR20	$6.29
R20	$4.30
PAR30	$10.96
PAR38	$11.70
Downlight Retrofit Kit	$8.41
LED Linear Lamps - Type A	$2.08
LED Linear Lamps - Type B	$2.11
LED Linear Lamps - Type C	$2.15
LED PL/G based CFL Replacement lamp	$7.56
LED Screw-in Lamps, HID Replacement	$41.59

Table 5: Labor Costs

Measure Category	Labor Cost
LED Linear Lamps - Type B	$8.00
LED Linear Lamps - Type C	$12.00
LED PL/G based CFL Replacement Lamp - Type B	$12.00
LED Screw-in Lamps, HID Replacement	$55.00

References:

1. "Lighting Efficiency - CO" and "Lighting - Small Business" participation data from 2016 through 2018.
2. Deemed Savings for 2019-2020 "Product: Lighting Efficiency - CO" to reference deemed values used to create weighted averages for HVAC Interactive Factors, Hours and CF.
3. Net-to-Gross factor from 2016 Xcel Energy Small Business Lighting Efficiency Program Evaluation

4. Energy Independence and Security Act. United States Congress. Jan 4, 2007. http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/eisa_2007.pdf
5. Adoption of Light-Emitting Diodes in Common Lighting Applications. Prepared for the U.S. Department Of Energy by Navigant Consulting. April 2013. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led-adoption-report_2013.pdf
6. Caliper Benchmark Report - Performance of Incandescent A-Type and Decorative Lamps and LED Replacements. U.S. Department of Energy. November, 2008. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/a-type_benchmark_11-08.pdf
7. ENERGY STAR ® Integral LED Product Qualifications Requirements. 2010.
8. Caliper Benchmark Report - Performance of Halogen Incandescent MR 16 Lamps and LED Replacements. U.S. Department of Energy. November, 2008. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/mr16_benchmark_11-08.pdf
9. Incandescent Reflector Lamps minimum efficacy standards. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/58
10. ENERGY STAR ® Certified Light Bulbs and Light Fixtures Qualified Products Lists. Accessed July 2018.
11. Actual sales data from distributors from the past two years. Collected June 2018.
12. Design Lights Consortium (2018). Qualified Products List as of February 27, 2018. (Lamp Lifetime Hours)
13. Hours of Use to calculate measure life for lamps was determined using a weighted hours of operation from Xcel Energy 2017/2018 participation.
14. 2015 U.S. Lighting Market Characterization. November 2017. https://www.energy.gov/sites/prod/files/2017/12/f46/lmc2015_nov17.pdf
15. Compared lumen equivalency data in the CO Lighting Efficiency downstream program from 2018 and 2019 to identify the baseline equivalency factors for the lamps.
16. "What is a ballast factor, and how does it affect my fluorescent tubes?". July 7, 2016. https://insights.regencylighting.com/what-is-a-ballast-factor-and-how-does-it-affect-my-fluorescent-tubes
17. Power Factor.https://assets.osram-americas.com/assets/documents/FAQ0056-0605.8d13d344-4cd2-42f2-af91-100b2a1a8a4d.pdf