14.3 Lighting Midstream

Algorithms

$$Customer\ kW = Quantity \times \frac{Watts\ Base - Watts\ EE}{1000} \times Cooling\ kW\ Savings\ Factor$$

$$Customer\ kWh = Quantity \times \frac{Watts\ Base - Watts\ EE}{1000} \times Hours \times Cooling\ kWh\ Savings\ Factor$$

$$Customer\ PCkW = Quantity \times \frac{Watts\ Base - Watts\ EE}{1000} \times Cooling\ kW\ Savings\ Factor \times CF$$

$$LPW\ EE = (Lumens\ EE)/(Watts\ EE)$$

$$Watts\ Base = Watts\ EE \times \frac{LPW\ EE}{LPW\ Base}$$

$$Natural\ Gas\ Savings\ (Dth) = Quantity \times \frac{Watts\ Base - Watts\ EE}{1000} \times Hours \times Heating\ Penalty\ Factor$$

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

$$Watts\ Base = Watts\ EE \times \frac{LPW\ EE}{LPW\ Base \times Baseline\ Equivelancy\ Factor \times Ballast\ Factor}$$

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

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

$$Customer\ kW = Quantity \times \frac{Watts\ Base - Sys\ Watts\ EE}{1000} \times Cooling\ kW\ Savings\ Factor$$

$$Customer\ kWh = Quantity \times \frac{Watts\ Base - Sys\ Watts\ EE}{1000} \times Hours \times Cooling\ kWh\ Savings\ Factor$$

$$Customer\ PCkW = Quantity \times \frac{Watts\ Base - Sys\ Watts\ EE}{1000} \times Cooling\ kW\ Savings\ Factor \times CF$$

$$Watts\ Base = Watts\ EE \times \frac{LPW\ EE}{LPW\ Base \times Baseline\ Equivelancy\ Factor \times Ballast\ Factor}$$

$$Sys\ Watts\ EE = (Watts\ EE)/(Ballast\ Efficiency)$$

Variables

LPW_Base	See Table 14.3.1	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	4,897	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. [12]
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. [26]
Baseline_Equivalency_Factor	See Table 14.3.2	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	See Table 14.3.3	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	See Table 14.3.4	Cost of the baseline technology.
Labor Cost	See Table 14.3.5	Cost of labor to install fixtures, Type B, and Type C lamps. [1]
NTG	78%	Net-to-gross factor.[14]

Customer Inputs	**M&V Verified**	
Quantity	No	Quantity of lamps or retrofit kits.
Measure Category	No	Type of lamp or retrofit kit.
Watts_EE	No	High efficiency lamp wattage. This is defined by the manufacturer and maintained and reported by the distributor.
Lumens_EE	No	High efficiency lamp rated brightness (lumens). This is defined by the manufacturer and maintained and reported by the distributor.
High Efficiency Cost	No	Cost of the high efficiency technology. Costs will be collected from the equipment distributor on the product invoice.

Table 14.3.1 Baseline Lamp Efficacy based on Lamp Category [15 - 20]

Measure Category	Avg. Efficacy
A Lamp rated for 310 - 749 Lumens (3 Way Lamps Excluded)	27.12
A Lamp rated for 750 - 1049 Lumens (3 Way Lamps Excluded)	36.88
A Lamp rated for 1050 - 1489 Lumens (3 Way Lamps Excluded)	39.45
A Lamp rated for 1490 - 2600 Lumens (3 Way Lamps Excluded)	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 Screw-in Lamp	83.20
LED Interior Fixture <= 25W	27.12
LED Interior Fixture <= 25W (CFL Base)	62.50
LED Interior Fixture 26W - 50W	37.93
LED Interior Fixture 26W - 50W (CFL Base)	59.80

Table 14.3.2 Baseline Equivalency Factor (BEF) [24]

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 14.3.3 Measure Lifetimes in Years [8, 21, 23]

Measure Category	2021 Lifetime	2022 Lifetime
LED Interior Lamp - A Lamp (3 Way Lamps Excluded)	5.2	5.2
General Directional (PAR, BR, R)	3.3	2.3
Multifaceted Reflector (MR16)	3.1	2.1
Decorative (B, BA, Candle, Globe)	3.4	2.4
Downlight Retrofit Kit	9.4	9.4
LED Linear & U-Bend Tubes - Type A & B	10.2	10.2
LED Linear & U-Bend Tubes - Type C & LED Interior Fixtures	20.0	20.0
LED PL/G based CFL Replacement lamp	10.2	10.2
LED Screw-in Lamps, HID Replacement	10.2	10.2

Table 14.3.4 Baseline Costs [22]

Measure Category	Baseline Cost
A19 60W, 750-1049 lm (3 Way Lamps Excluded)	$2.36
A19 100W, 1490-2600 lm (3 Way Lamps Excluded)	$3.28
Decorative (Candle/Globe)	$1.84
BR30	$3.39
BR40	$7.06
MR16	$2.64
PAR16	$5.99
PAR20	$5.45
R20	$4.30
PAR30	$6.85
PAR38	$8.89
Downlight Retrofit Kit	$8.41
LED Linear Lamps - Type A	$2.19
LED Linear Lamps - Type B	$2.07
LED Linear Lamps - Type C	$2.18
LED PL/G based CFL Replacement lamp	$4.59
LED Screw-in Lamps, HID Replacement	$37.68

Table 14.3.5 Labor Costs [12]

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
LED Interior Fixtures	$60.00
LED Interior Fixtures (CFL Base)	$25.00