14.1 Lighting Controls

Algorithms

$$Customer\ kW = kW\ Connected \times \%\ Savings \times Cooling\ kW\ Savings\ Factor$$

$$Customer\ kWh = kW\ Connected \times \%\ Savings \times Hours \times Cooling\ kWh\ Savings\ Factor$$

$$Customer\ PCkW = kW\ Connected \times \%Savings \times Cooling\ kW\ Savings\ Factor \times CF$$

$$Natural\ Gas\ Savings\ (Dth) = kW\ Connected \times \%\ Savings \times Hours \times Heating\ Penalty\ Factor$$

Variables

Cooling_kW_Savings_Factor	See Table 14.0.1	Cooling system secondary demand savings factor resulting from efficient lighting. Reduction in lighting demand results in a reduction in cooling demand, if the customer has air conditioning. Existence of air conditioning determined by HVAC_Type.
Cooling_kWh_Savings_Factor	See Table 14.0.1	Cooling system secondary energy savings factor resulting from efficient lighting. Reduction in lighting energy results in a reduction in cooling energy, if the customer has air conditioning. Existence of air conditioning determined by HVAC_Type.
Heating_Penalty_Factor	See Table 14.0.1	Heating system secondary energy penalty factor resulting from efficient lighting. Reduction in lighting demand results in an increase in heating usage, if the customer has gas heating. Existence of gas heating to be determined by HVAC_Type.
CF	See Table 14.0.3	Coincidence Factor is the probability that the peak demand of the lights will coincide with the peak utility system demand, determined by Facility_Type.
Hours	See Table 14.0.3	Annual operating hours, determined by Facility_Type.
% Savings	See Table 14.1.1	Stipulated savings percentage based on control type.
Measure Life	See Table 14.0.2	Length of time the lighting equipment will be operational.
NTG	See Table 14.1.2	Net-to-gross.

Customer Inputs	**M&V Verified**	
HVAC_Type	Yes	Type of heating or cooling, verified during M&V.
Facility_Type	No	Type of facility.
kW_Connected	Yes	Total connected fixture load connected to lighting controls, provided by customer and verified during M&V.

Table 14.1.1 Lighting Controls [4, 5, 12]

Control Type	% Savings	Full Cost Per Watt
Standalone or Integrated LLLC - Occupancy Sensor	24%	$0.49
Standalone or Integrated LLLC - Daylighting (Photocell) Sensor	28%	$0.49
Standalone or Integrated LLLC - Occupancy and Daylighting (Photocell) Sensor	38%	$0.49
Networked Lighting Controls (w & w/o LLLC)	49%	$0.97
Integrated LLLC - High End Trim	29%	$0.48

Table 14.1.2 Net To Gross[11, 28]

Program	NTG %
Lighting Efficiency	100%
Small Business Solutions	94%

References:

4. Design Lights Consortium. (2017). Energy Savings from Networked Lighting Control (NLC) Systems. Medford: Design Lights Consortium. Retrieved 1 23, 2020, from https://www.designlights.org/lighting-controls/reports-tools-resources/nlc-energy-savings-report/

5. Lawrence Berkeley National Laboratory. (2011). A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings. Berkeley, CA: Lawrence Berkeley National Laboratory. Retrieved 10 01, 2017, from https://eta.lbl.gov/sites/default/files/publications/a_meta-analysis_of_energy_savings_from_lighting_controls_in_commercial_buildings_lbnl-5095e.pdf

6. Measure Life for automatically controlled measures from the Deemed Savings for CO Energy Management Systems, 2019-2020. (NLC Measure Life)
11. The Unopposed Settlement Agreement in Proceeding No. 18A-0606EG.
12. "Lighting Efficiency - CO" and "Lighting - Small Business" participation data
28. Net-to-Gross factor from the Evaluation of Xcel Energy's Small Business Solutions Program. 2020. EMI Consulting.
29. Design Lights Consortium. Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC. Sept 24, 2020. https://www.designlights.org/resources/reports/report-
30. NEEA. 2020 Luminaire Level Lighting Controls Incremental Cost Study. https://neea.org/img/documents/2020-LLLC-Incremental-Cost-Study.pdf

14.6 Grow Lighting

Algorithms

$$Customer\ kW = \left(\left(\frac{Proposed\ Fixture\ kW\ *\ Proposed\ Quantity\ *\ \%Reflector\ Eff_{prop}\ *\ Proposed\ PPE}{\%Reflector\ Eff_{base} * Baseline\ PPE}\right) - Proposed\ Quantity * Proposed\ Fixture\ kW\right) * Cooling\ kW\ Savings\ Factor$$

$$Customer\ kWh = \left(\left(\frac{Proposed\ Fixture\ kW\ *\ Proposed\ Quantity\ *\ \%Reflector\ Eff_{prop}\ *\ Proposed\ PPE}{\%Reflector\ Eff_{base} * Baseline\ PPE}\right) - Proposed\ Quantity * Proposed\ Fixture\ kW\right) * Hours\ * Cooling\ kWh\ Savings\ Factor$$

$$PCkW = Customer\ kW\ *\ CF$$

Variables

%Reflector Eff_base	78.3%	Accounts for reflector losses and amount of useful light delivered using baseline fixtures [2]
%Reflector Eff_prop	97.2%	Accounts for reflector losses and amount of useful light delivered from LED grow lights [2]
Cooling kW Savings Factor*	1.33	Assuming year round A/C cooling for indoor grow facilities
Cooling kWh Savings Factor*	See Table 14.0.1	Assuming year round A/C cooling for indoor grow facilities
Hours	See Table 14.6.1	Annual Hours of Operation
CF	See Table 14.6.1	Coincidence Factor
Incremental Cost	See Table 14.6.2	Average fixture costs per watt based weighted against total watts from historical custom projects
Baseline PPE	See Table 14.6.3	Average value weighted against historical custom project baseline wattage

** These values assume year round mechanical cooling in all facilities. This is the current standard assumption for custom analysis.*

Customer Inputs	M&V Verified	
Grow Room Type*	Yes	Flower or Veg
Proposed Fixture Quantity	Yes	Number of proposed LED grow fixtures being installed
Proposed Fixture PPE (PPF/W)	Yes	Umols/J from spec sheet or DLC listing
Proposed Fixture kW	Yes	kW per proposed LED fixture
Total Equipment Cost	No	Field only used for data collection to update cost assumptions to match changing market conditions
Total Labor Cost	No	Field only used for data collection to update cost assumptions to match changing market conditions

Table 14.6.1: Operating Schedule [1, 4]

Grow Room Type	Annual Hours*	CF*	Cooling kWh Savings Factor
Cannabis Flower Room	4,255	0.68	1.16
Cannabis Veg Room	6,498	0.89	1.24
Flowering Crops (Tomatoes/Peppers/Flowers)	4,200	0.76	1.21
Vegetative/Propagation Growth	6,300	0.95	1.21
Microgreens	6,300	0.95	1.21

** Cannabis values are calculated averages of custom indoor grow project operating schedules*

Table 14.6.2: Incremental Cost per Watt [1]

Baseline Cost/W*	Proposed Cost/W**
$ 0.27	$ 1.40

** Calculated as average baseline cost per watt from historical custom projects weighted against baseline wattage*
*** Calculated as average proposed cost per watt from historical custom projects weighted against proposed wattage*

Table 14.6.3: Baseline PPF [2]

	PPE	Wtd Avg PPE** [1]
Mogul Based HPS	1.02	1.08
DE HPS	1.7	
CMH	1.46	
Fluorescent*	0.84	

** The reference for this was specific to T8. Due to lack of sources T5 is assumed to be equivelant*
*** Baseline average PPE calculated form historical custom projects and weighted against total baseline watts. We investigated using seperate values based on room type but found only a 3% difference between flower and veg and determined a single value was sufficient.*

References:

1. Historical custom grow lighting projects from 2020. 54 spaces and over 5500 proposed fixtures.
2. LED and HID Horticultural Luminaire Testing Report, Lighting Energy Analysis, Natural Resourced Canada, 2018: https://www.lrc.rpi.edu/programs/energy/pdf/HorticulturalLightingReport-Final.pdf
3. Energy Savings Potential of SSL in Horticultural Applications, US Department of Energy Office of Energy Efficiency and Renewable Energy, December 2017: https://www.energy.gov/sites/prod/files/2017/12/f46/ssl_horticulture_dec2017.pdf
4. State of Illinois Technical Reference Manual, Version 9.0 Final Technical Version as of October 17th, 2019. Effective January 1st, 2021.