



**CALIFORNIA  
ENERGY**  
CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Title 24, Part 11  
Local Energy Efficiency Ordinances

## **Energy Cost-Effectiveness Study for Nonresidential Outdoor Lighting Power Allowances**

**Prepared for:**

Codes and Standards Program  
Pacific Gas and Electric Company

**Prepared by:**

Energy Solutions

Last Modified: July 22, 2016



A Sempra Energy utility®



A Sempra Energy utility®



An EDISON INTERNATIONAL® Company



## LEGAL NOTICE

This report was prepared by Pacific Gas and Electric Company and funded by the California utility customers under the auspices of the California Public Utilities Commission.

Copyright 2016, Pacific Gas and Electric Company. All rights reserved, except that this document may be used, copied, and distributed without modification.

Neither PG&E nor any of its employees makes any warranty, express or implied; or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any data, information, method, product, policy or process disclosed in this document; or represents that its use will not infringe any privately-owned rights including, but not limited to, patents, trademarks or copyrights.

# Contents

<b>1. Executive Summary</b> .....	<b>1</b>
<b>2. Summary of Findings</b> .....	<b>2</b>
2.1 Opportunities .....	2
2.1.1 Outdoor Lighting Ordinance Opportunities.....	3
<b>3. Methodology and Assumptions</b> .....	<b>5</b>
<b>4. Energy Savings</b> .....	<b>5</b>
4.1 Savings from Adoption of LPAs Beyond the 2016 Standards.....	5
<b>5. Cost Analysis</b> .....	<b>7</b>
5.1 Market Analysis and Regulatory Impact Assessment.....	7
5.2 Incremental Cost Results .....	7
5.3 Cost-effectiveness.....	8
<b>6. References</b> .....	<b>9</b>
<b>Appendix A : Energy Savings Calculations</b> .....	<b>10</b>
<b>Appendix B : Cost-Effectiveness Calculations</b> .....	<b>15</b>
<b>Appendix C : Lighting Use Profiles</b> .....	<b>18</b>
<b>Appendix D : Energy Savings For Cities</b> .....	<b>21</b>
<b>Appendix E : Available Luminaires Capable of Meeting Reach Table 140.7-B Requirements</b> .....	<b>24</b>
<b>Appendix F Reach Table 140.7-B</b> .....	<b>29</b>

# 1. EXECUTIVE SUMMARY

---

Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards (Standards) establish a process which allows local jurisdictions to adopt energy standards that are more stringent than the statewide Standards. This process allows local governments to adopt and enforce energy standards before the statewide Standards effective date, require additional energy conservation measures, and/or set more stringent energy budgets.

The process for adopting a local ordinance requires that local governments apply to California Energy Commission (CEC) for approval. The applicant jurisdiction must document the supporting analysis for determining that the proposed ordinance will save more energy than the current statewide Standards. The applicant jurisdiction must also prepare a Cost Effectiveness Study that provides the basis of the local government's determination that the proposed ordinance is cost effective. Once CEC staff has verified that the local ordinance will require buildings to use no more energy than the current statewide Standards and that the documentation requirements in Section 10-106 are met, the application is brought before the full California Energy Commission for approval. Applicants must also file the ordinance with the Building Standards Commission.

This Cost Effectiveness Study provides information on energy savings and cost-effectiveness to support mandatory requirements reducing the maximum power allowed for Nonresidential Outdoor Lighting beyond the 2016 requirements. Outdoor lighting standards include requirements for general hardscape areas as well as additional allowances for specific applications. Changes adopted in the 2016 Standards increased the stringency for general hardscape areas but made few changes to the specific application areas. This study proposed reduction in seven of the specific application areas: Primary Entrances for specific emergency and medical facilities, Drive-Up Windows, Outdoor Sales Frontage, Outdoor Sales Lots, Vehicle Service Station hardscape areas, Non-Sales Canopies and Tunnels, and Outdoor Dining areas.

Pulse Start Metal Halide (PSMH) has been used as the baseline technology for Nonresidential Outdoor LPA historically, but advances in technology along with dropping costs are making Light Emitting Diode (LED) a viable replacement. New lighting power allowances (LPAs) were adopted into the 2016 Building Energy Efficiency Standards (Title 24, Part 6) by the CEC in June 2015 and will go into effect statewide January 1, 2017. This Cost-Effectiveness Study includes an analysis to help local governments garner additional energy savings by adopting measures that are more stringent than the newly adopted 2016 LPAs. The analysis in this report demonstrates that these requirements are cost-effective, technically feasible, and would result in additional energy savings beyond minimum state requirements in adopting jurisdictions.

## 2. SUMMARY OF FINDINGS

---

- This proposal replaces outdoor PSMH light sources with LED lighting as the basis for determining the maximum allowed lighting power in certain applications. In addition to the direct savings resulting from reducing the lighting power, LED technology enables use of more advanced lighting controls and controls strategies, including bi-level lighting and potentially also reducing hours of operation. This proposal applies to new construction as well as retrofits that replace more than 50% of existing outdoor luminaires.
- Implementation of the Nonresidential Outdoor LPA measures proposed herein are cost effective. The entire measure Benefit to Cost (B/C) ratio is 3.33.



- LED technology is rapidly claiming a large portion of the exterior lighting market, and the market adoption of LED products is anticipated to accelerate as the cost of LED products continues to decrease.
- Further reductions in Nonresidential Outdoor LPA values will be possible as LED technology advances.
- High efficiency LED lighting sources make it feasible to meet IES recommended illuminance levels within the reduced lighting power allowances proposed here. At no point in this LPA adjustment will the lighting design criteria be changed. This basis of design has been established by the Illumination Engineering Society (IES) in a variety of sources and mapped as part of the previous Title 24 Outdoor Lighting Case Studies (CASE 2007). This matrix of design criteria was reviewed to ensure that no specific recommendations have changed, and therefore, no changes are needed to the illuminance criterion that establishes the LPA values.
- This report finds that the Reach Table 140.7-B is cost-effective and may be used to replace the 2013 Table 140.7-B in the current standards (which will be in effect statewide until 12/31/2016) and/or the 2016 Table 140.7-B (which will be in effect statewide starting 1/1/2017). The Outdoor LPA values in the Reach Table 140.7-B in this report are likely to be proposed for the 2019 Title 24 code change (which will take effect statewide 1/1/2020), however, due to the rapid improvement of LED technology, the wattage allowances will likely be even lower than what is presented in Reach Table 140.7-B.
- The total measure<sup>1</sup> impacts of the LPAs in the proposed Reach Table 140.7-B for a city with a population of 100,000 would be 1.27 gigawatt-hours saved and a reduction of 449 metric tons of carbon dioxide per year. These savings are only based on new construction and do not account for savings from alterations or retrofits.
- Outdoor Lighting Zones are geographic areas designated by the California Energy Commission in accordance with Article 1, Section 10-114 in Title 24, Part 6 that determines requirements for outdoor lighting, including lighting power densities and specific control, equipment or performance requirements. Lighting zones are numbered LZ0, LZ1, LZ2, LZ3, and LZ4. They are based on ambient light levels which is largely related to population density. Jurisdictions must know which lighting zone(s) are covered in their territory in order to ensure proper LPA values are used.

## 2.1 Opportunities

The sections below provide a summary of the identified opportunities for local governments to gain savings through adoption of the new Reach Table 140.7-B. The modifications are explained in Section 2.1.1 below.

The adopted 2016 code change or the new Reach Table 140.7-B do not modify any sections of the Title 24 Reference Appendices for the nonresidential outdoor lighting controls standards.

---

<sup>1</sup> Total Measure Savings is calculated as the savings achieved from all forecasted installations in a city of a given size between 2017-2019, and over a 15 year period of analysis for those installations.



### 2.1.1 Outdoor Lighting Ordinance Opportunities

The following seven specific application areas represent opportunities for local governments to adopt outdoor lighting standards that are stronger than the 2016 standards. The 2016 adopted wattages being replaced are in ~~strike through~~ text and red, while the proposed wattages are underlined and green. The following measures offer long-term energy savings opportunities for local governments as these values are not expected to be re-considered at the state level until the 2019 code cycle (which takes effect statewide in 2020). Please note that wattage allowances proposed for the 2019 code change cycle will likely be even lower than what is presented in the Reach Table 140.7-B. The wattage allowances presented are based on luminaires available immediately (2016 & 2017), while the wattage allowances likely to be proposed for the 2019 code cycle will reflect luminaires projected to be available in 2020. Please see Section 5.3 for details on the cost-effectiveness of the measures.

#### 2.1.1.1 Reach Table 140.7-B

Table 140.7-B ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.					
<b>Building Entrances or Exits.</b> Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not Applicable	15 watts	25 watts	35 watts	45 watts
<b>Primary Entrances to Senior Care Facilities, Police Stations, Hospitals, Fire Stations, and Emergency Vehicle Facilities.</b> Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not Applicable	<del>45</del> <u>20</u> watts	<del>80</del> <u>40</u> watts	<del>120</del> <u>60</u> watts	<del>130</del> <u>80</u> watts
<b>Drive Up Windows.</b> Allowance per customer service location. Luminaires qualifying for this allowance shall be within 2 mounting heights of the sill of the window.	Not Applicable	<del>40</del> <u>30</u> watts	<del>75</del> <u>40</u> watts	<del>125</del> <u>60</u> watts	<del>200</del> <u>100</u> watts
<b>Vehicle Service Station Uncovered Fuel Dispenser.</b> Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within 2 mounting heights of the dispenser.	Not Applicable	120 watts	175 watts	185 watts	330 watts
<b>ATM Machine Lighting.</b> Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not Applicable	250 watts for first ATM machine, 70 watts for each additional ATM machine			
WATTAGE ALLOWANCE PER UNIT LENGTH (w/linear ft). May be used for one or two frontage side(s) per site.					
<b>Outdoor Sales Frontage.</b> Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	Not Applicable	No Allowance	<del>22.5</del> <u>15</u> W/linear ft	<del>36</del> <u>25</u> W/linear ft	<del>45</del> <u>30</u> W/linear ft
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft <sup>2</sup> ). May be used for any illuminated hardscape area on the site.					
<b>Hardscape Ornamental Lighting.</b> Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 100 watts or less as determined in accordance with Section 130.0(d), and shall be post- top luminaires, lanterns, pendant luminaires, or chandeliers.	Not Applicable	No Allowance	0.02 W/ft <sup>2</sup>	0.04 W/ft <sup>2</sup>	0.06 W/ft <sup>2</sup>



<b>WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft<sup>2</sup>). Use as appropriate provided that none of the following specific applications shall be used for the same area.</b>					
<b>Building Facades.</b> Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.	Not Applicable	No Allowance	0.18 W/ft <sup>2</sup>	0.35 W/ft <sup>2</sup>	0.50 W/ft <sup>2</sup>
<b>Outdoor Sales Lots.</b> Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non-sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.	Not Applicable	<del>0.164</del> 0.100 W/ft <sup>2</sup>	<del>0.555</del> 0.250 W/ft <sup>2</sup>	<del>0.758</del> 0.500 W/ft <sup>2</sup>	<del>1.285</del> 1.000 W/ft <sup>2</sup>
<b>Vehicle Service Station Hardscape.</b> Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	Not Applicable	<del>0.014</del> 0.010 W/ft <sup>2</sup>	<del>0.155</del> 0.100 W/ft <sup>2</sup>	<del>0.308</del> 0.150 W/ft <sup>2</sup>	<del>0.485</del> 0.200 W/ft <sup>2</sup>
<b>Vehicle Service Station Canopies.</b> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not Applicable	0.514 W/ft <sup>2</sup>	1.005 W/ft <sup>2</sup>	1.300 W/ft <sup>2</sup>	2.200 W/ft <sup>2</sup>
<b>Sales Canopies.</b> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not Applicable	No Allowance	0.655 W/ft <sup>2</sup>	0.908 W/ft <sup>2</sup>	1.135 W/ft <sup>2</sup>
<b>Non-sales Canopies and Tunnels.</b> Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or	Not Applicable	<del>0.084</del> 0.080 W/ft <sup>2</sup>	<del>0.205</del> 0.160 W/ft <sup>2</sup>	<del>0.408</del> 0.300 W/ft <sup>2</sup>	<del>0.585</del> 0.400 W/ft <sup>2</sup>
<b>Guard Stations.</b> Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within 2 mounting heights of a vehicle lane or the guardhouse.	Not Applicable	0.154 W/ft <sup>2</sup>	0.355 W/ft <sup>2</sup>	0.708 W/ft <sup>2</sup>	0.985 W/ft <sup>2</sup>
<b>Lighting Application</b>	<b>Lighting Zone 0</b>	<b>Lighting Zone 1</b>	<b>Lighting Zone 2</b>	<b>Lighting Zone 3</b>	<b>Lighting Zone 4</b>
<b>Student Pick-up/Drop-off zone.</b> Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within 2 mounting heights of the student pick-up/drop-off zone.	Not Applicable	No Allowance	0.12 W/ft <sup>2</sup>	0.45 W/ft <sup>2</sup>	No Allowance
<b>Outdoor Dining.</b> Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within 2 mounting heights of the hardscape area of outdoor dining.	Not Applicable	<del>0.014</del> 0.010 W/ft <sup>2</sup>	<del>0.135</del> 0.100 W/ft <sup>2</sup>	<del>0.240</del> 0.150 W/ft <sup>2</sup>	<del>0.400</del> 0.200 W/ft <sup>2</sup>
<b>Special Security Lighting for Retail Parking and Pedestrian Hardscape.</b> This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not Applicable	0.007 W/ft <sup>2</sup>	0.009 W/ft <sup>2</sup>	0.019 W/ft <sup>2</sup>	No Allowance



### 3. METHODOLOGY AND ASSUMPTIONS

---

This document builds upon the 2016 Codes and Standards Enhancement (CASE) reports for Nonresidential Outdoor Lighting Power Allowance in the Title 24 Building Energy Efficiency Standards to support the reach code requirements for Nonresidential Outdoor Lighting Power Allowance (CASE 2014, CASE 2015).

The Outdoor LPA values in Title 24 are subject to change as new technologies (in particular, light source technologies that increase lamp efficacy) become available to the market. As a result, the LPA values have continued to slowly move downward over time in response to these technological advancements.

LED light source technology is advancing rapidly, and the raw lamp efficacy of LED light sources is rapidly improving beyond that of both PSMH (the baseline standard), and High Pressure Sodium (HPS) light sources. As a result, LED is rapidly claiming a large portion of the exterior lighting market, and the market adoption of LED is anticipated to accelerate as the cost of LED products continues to decrease.

This measure intends to replace PSMH light sources with LED as the basis for the calculation of LPA in certain applications. CEC adopted the 2016 Standards and Reference Appendices on June 10, 2015.

### 4. ENERGY SAVINGS

---

The sections below provide the energy savings for a typical city of 100,000 associated with adopting the new Reach Table 140.7-B. Statewide energy savings were calculated for the Reach Table 140.7-B and then scaled down by population to estimate energy savings a typical city of 100,000 can expect to see. Please note that these savings are for new construction only and do not account for savings from alterations or retrofits. Please see Appendix A for information on statewide savings associated with the new Reach Table 140.7-B and Appendix D for additional estimations of energy savings for cities of other sizes.

#### 4.1 Savings from Adoption of LPAs Beyond the 2016 Standards

The first year potential impacts of the new Reach Table 140.7-B can be expected to reduce annual electricity use by 0.03 gigawatt-hours per year and avoid 9.97 MTCO<sub>2</sub> per year for a typical city of 100,000. Retrofitting existing outdoor lighting installations will result in additional savings, dependent on the volume of retrofit activity. These loads have a primarily nighttime profile, and demand reduction is anticipated to take place after peak demand periods, thus it is not included here. Please see Appendix C for details on lighting use profiles. Please see Appendix D for details on first year energy savings that other sized cities can expect by replacing their current (or 2016) Table 140.7-B with the new Reach Table 140.7-B.

The energy impacts per unit for each lighting zone for the Primary Entrances, Drive Up Windows, Outdoor Sales Frontage, Outdoor Sales Lots, Vehicle Service Station Hardscape, Non-sales Canopies, and Outdoor Dining are found in Table 1: Energy Impacts per Unit For all Lighting Zones.





**Table 1: Energy Impacts per Unit For all Lighting Zones**

Lighting Application	Per Unit First Year Savings by Lighting Zone <sup>1</sup>				
	Units	LZ1 Electricity Savings <sup>2</sup> (kWh/yr)	LZ2 Electricity Savings <sup>2</sup> (kWh/yr)	LZ3 Electricity Savings <sup>2</sup> (kWh/yr)	LZ4 Electricity Savings <sup>2</sup> (kWh/yr)
Primary Entrances	Each	117	188	281	57
Drive Up Windows	Each	34	120	223	343
Outdoor Sales Frontage	Per linear foot	N/A	15	21	29
Outdoor Sales Lots	Per Square Foot	0.22	1.1	0.89	0.98
Vehicle Service Station Hardscape	Per Square Foot	0.02	0.27	0.65	1.18
Non-sales Canopies	Per Square Foot	0.02	0.21	0.51	0.87
Outdoor Dining	Per Square Foot	0.01	0.06	0.14	0.31

1. Savings from one unit for the first year the site is in operation.

2. Site electricity savings. Does not include TDV of electricity savings.

Table 2: Typical city of 100,000 Estimated First Year and Total Measure Electricity Savings and First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B is a summarization of the estimated potential energy savings and GHG reductions over the first twelve months of implementation and the total measure<sup>2</sup> energy savings and GHG reductions of the Reach Table 140.7-B for a typical city of 100,000. The CEC Demand Analysis Office provided nonresidential new construction forecast data for 2017 that was used to estimate the total area of each specific application. Since outdoor hardscape is not estimated as part of the construction forecasts, proxies with reasonable estimates of the relationship of the line items to gross square footage of indoor spaces were used. In effect, the estimates relate the unit of the measure (square foot of outdoor dining for example) with an equivalent unit of gross interior space, which can then be projected using the construction forecasts. We calculated that California will build approximately 100 new Primary Entrances, 1,146 new Drive Up Windows, 150,000 new linear feet of Outdoor Sales Frontage, 3 million new square feet of Outdoor Sales Lots, 5.5 million new square feet of Vehicle Service Station Hardscape, over 3 million new square feet of Non-sales Canopies, and 760,000 new square feet of Outdoor Dining in 2017. Total statewide new construction energy savings were calculated from these totals, and population was used as a proxy to scale down and estimate savings for a typical city of 100,000. Please see Appendix A for more details on statewide savings.

Avoided greenhouse gas (GHG) emissions were calculated using a factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings. Please see Appendix D for details on electricity savings and GHG emissions reductions that cities of other sizes can expect to see by replacing their current (or 2016) Table 140.7-B with the new Reach Table 140.7-B.



**Table 2: Typical city of 100,000 Estimated First Year and Total Measure<sup>3</sup> Electricity Savings and First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B**

	First Year and Total Measure Savings			
	First Year Electricity Savings (GWh)	Total Measure Savings (GWh)	First Year Statewide Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)	Total Measure Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)
<b>Total</b>	0.03	1.27	9.97	449

<sup>1</sup>. Avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings.

## 5. COST ANALYSIS

### 5.1 Market Analysis and Regulatory Impact Assessment

The industry as a whole is helping to drive the change to LED light sources. Manufacturers are actively funding research and development (R&D) efforts for the LED market, putting most of their R&D funds into LED product development (TRC 2014). As a result, manufacturers are already supporting this change and are working to be well positioned for this market shift.

### 5.2 Incremental Cost Results

The useful life of LED luminaires exceeds the 15 year measure life assumed by the CEC in the cost-effectiveness analysis considerably, and is expected to persist longer than incumbent lighting solutions in most cases. Maintenance costs for LED lighting products are reduced because the long life of the LED chips eliminates the need for lamp replacements associated with PSMH and other incumbent sources.

Incremental cost was calculated by updating the 2016 Nonresidential Outdoor Lighting Power Allowance CASE Report cost-effectiveness calculations with new cost data from manufacturers. The new cost data was obtained through recent manufacturer interviews. This was done to confirm that the cost declines have continued at the rate predicted by DOE and used in the CASE Report – in fact cost declines have occurred more quickly than predicted in most cases. Prices in late 2015 were already on par with or lower than the prices projected in the CASE report for 2017. For the specific lighting allowances in Table 140.7-B in Title 24, the LED light source is unlikely to be able to substantially change the designs because there are other factors that determine the equipment locations and quantities. Key assumptions used to derive cost are presented in Figure 1.

<sup>3</sup> Total Measure Savings is calculated as the savings achieved from all forecasted installations in a city of a given size between 2017-2019, and over a 15 year period of analysis for those installations.



**Figure 1: LED Chip Efficacy and Price Projections (DOE 2013)**

Metric	2012	2013	2015	2020	Goal
Cool-White Efficacy (lm/W)	150	164	190	235	266
Cool-White Price (\$/klm)	6	4	2	0.7	0.5
Warm-White Efficacy (lm/W)	113	129	162	224	266
Warm-White Price (\$/klm)	7.9	5.1	2.3	0.7	0.5

Note: Projections for cool-white packages assume CCT=4746-7040 K and CRI >70, while projections for warm-white packages assume CCT=2580-3710 K and CRI >80. All efficacy projections assume that packages are measured at 25 °C with a drive current density of 35 A/cm<sup>2</sup>.

### 5.3 Cost-effectiveness

A number of measures were rejected for the 2016 code cycle due to not being cost-effective when these measures were first analyzed in 2013-2014. These measures were reassessed in spring 2016 using updated cost information, given the significant reductions that have occurred in LED pricing. With the new cost information in place, seven of the rejected measures are shown to be cost-effective now. Note that the values being pursued for the 2019 code cycle are likely to be even lower than presented in this report due to additional efficiency gains LEDs are expected to achieve over the next few years. Table 3: Reach Code Beyond 2016 Standards: Cost-effectiveness Summary1 – Weighted Average Across Lighting Zones below provides the cost-effectiveness summary of these measures.



**Table 3: Reach Code Beyond 2016 Standards: Cost-effectiveness Summary<sup>1</sup> – Weighted Average Across Lighting Zones**

Climate Zone	Units	Benefit: TDV Energy Cost Savings <sup>2</sup> (2017 PV\$)	Cost: Total Incremental Cost <sup>3</sup> (2017 PV\$)	Change in Lifecycle Cost <sup>4</sup> (2017 PV\$)	Benefit to Cost Ratio <sup>5</sup>
Primary Entrances	Each	407.74	Lower	-407.74	Infinite
Drive Up Windows	Each	380.43	148.00	-232.43	2.6
Outdoor Sales Frontage	Per linear foot	32.68	28.45	-4.23	1.1
Outdoor Sales Lots	Per Square Foot	1.61	0.29	-1.32	5.6
Vehicle Service Station Hardscape	Per Square Foot	1.05	0.04	-1.01	28.8
Non-sales Canopies	Per Square Foot	0.71	Lower	-0.71	Infinite
Outdoor Dining	Per Square Foot	0.21	Lower	-0.21	Infinite

1. Relative to existing conditions. All cost values presented in 2017 dollars.
2. Present value of TDV cost savings equals TDV electricity savings plus TDV natural gas savings;  $\Delta TDV\$ = \Delta TDV\$\text{E} + \Delta TDV\$\text{G}$ .
3. Total incremental cost equals incremental construction cost (post adoption) plus present value of incremental maintenance cost;  $\Delta C = \Delta C\text{I}_{\text{PA}} + \Delta \text{CM}$ .
4. Negative values indicate the measure is cost-effective (a reduction in the total lifecycle cost). Change in lifecycle cost equals cost premium minus TDV energy cost savings;  $\Delta \text{LCC} = \Delta C - \Delta TDV\$$
5. The benefit to cost ratio is the TDV energy costs savings divided by the total incremental costs;  $\text{B/C} = \Delta TDV\$ \div \Delta C$ . The measure is cost effective if the B/C ratio is greater than 1.0.

Many of the proposed lighting systems have been found to cost less than the incumbent PSMH lighting systems. This is especially true when considering cost forecasts for LED products. However, this analysis conservatively assumes zero cost difference between the existing and proposed conditions in circumstances when the installed cost is lower.

See Appendix B for additional information on the cost-effectiveness calculations.

## 6. REFERENCES

- [CASE 2014] C&S Team, 2014. *Nonresidential Outdoor Lighting Power Allowance*. PG&E, SCE, SDGE, SCGC, LADWP IOU Statewide CASE Team, December, 2014.
- [CASE 2015] C&S Team, 2015. *Results Report - Nonresidential Outdoor Lighting Power Allowance*. PG&E, SCE, SDGE, SCGC, LADWP IOU Statewide CASE Team, September, 2015.
- [DOE 2013] U.S. Department of Energy. 2013. *Solid-State Lighting Research and Development Multi-Year Program Plan*. DEO/EERE 9061. Washington, D.C.: U.S. Department of Energy.
- [Navigant 2012] Navigant Consulting, Inc. 2012. *Energy Savings Potential of Solid-State Lighting in General Illumination Applications*. Washington, D.C.: U.S. Department of Energy.
- [TRC 2014] TRC Energy Services. Communications with Manufacturers on the LED Market. Ongoing communications and observations from 2013 and 2014.



# Appendix A: ENERGY SAVINGS CALCULATIONS

## Statewide Energy Savings

Outdoor lighting areas in nonresidential new construction are not included in the CEC's new construction forecasts, so the impact of the various lighting measures were predicted based on other metrics that rely on indoor construction square footage as the basis of measurement. Assumptions for how the individual line items of the measure are calculated to the statewide impacts are presented below. These savings do not account for alterations or retrofits.

## Translation of Lighting Zones to Statewide Impacts

The definition of the Lighting Zones is tied to the US Census (2010), and is related to the classification of land mass designated as Urban or Rural, which is the demarcation line between Lighting Zone 2 (rural) and Lighting Zone 3 (urban).

**Table 4: Lighting Zone Area and Likely Construction Activity within the Respective Lighting Zones in the State**

Lighting Zone	Percent of Land Mass (Source: 2010 US Census)	Percent of Construction Activity (Estimate)
LZ0	9%	0%
LZ1	1%	0.1%
LZ2	85%	9.9%
LZ3	5%	90%
LZ4	0%	0%

Note that the Census data only provides information on land mass in LZ0, LZ1, and LZ2 as a single group, and similarly, LZ3 and LZ4 as another group. LZ4 has not been employed in the state by any jurisdiction, and LZ2 represents the preponderance of the state area outside designated State and National parks.

At least 90% of electricity consumption is designated to urban areas in the Census, and as a result, the strong majority of new construction activity is also centered on the urban centers. (RLW 2002a)

The Census designations of Urban and Rural are not directly equivalent to the developed ZIP Codes in the state, which are employed for the State mapping. The Census data uses larger blocks for the mapping, so there may be are likely segments of rural land that are captured in the Urban Census designation due to the population within the larger Census block. The Urban areas in the state are growing at a higher pace than the construction forecasts might directly project.



## **Translation of Individual Line Items to Statewide Impacts**

Since the outdoor hardscape is not estimated as part of the construction forecasts, statewide impacts were completed by making proxies with reasonable estimates of the relationship of the line item to the potential gross square footage of indoor spaces associated with the measure.

In effect, the estimates relate the unit of the measure (square foot of hardscape, for example), with an equivalent unit of gross interior space, which were then projected using the constructions forecasts.

Assumptions regarding how the individual line items of the measure were calculated to the statewide impacts are presented in Table 5: Proxy Assumptions for Statewide Impacts Estimate Calculations for Specific Applications below.



**Table 5: Proxy Assumptions for Statewide Impacts Estimate Calculations for Specific Applications**

Assumptions for Statewide Estimates - Specific Applications			Applied to % of Building S.F. in Category								
Lighting Allowance	Assumptions		Office, LG & SM	Retail	Restaurant	Food (Grocery)	Warehouse, Ref & NR	Hotel	School	College	Other
Building Entrances or Exits	<b>1 per 5000 sf of building interior</b> (20 occupants per door, 250 occ/sf)		100%	100%	100%	100%	100%	100%	100%	100%	99%
Primary Entrances to Senior Care Facilities, Police Stations, Hospitals, Fire Stations, and Emergency Vehicle Facilities	<b>1 per 5000 SF of gross building area</b> (1 primary entrance per building)										1%
Drive Up Windows	<b>1 per 1500 SF of gross building area</b> (2 locations per building; 1000 sf building)				30%						
Vehicle Service Station Uncovered Fuel Dispenser	<b>1 per 100 sf of gross building area</b> (1 fuel dispenser face per 25 sf of station building interior)										0.01%
Automated Teller Machines	<b>400W MH luminaire as typical standard practice, switch to 250W limit for first location, 2500 sf per ATM installation.</b>										1%
Outdoor Sales Frontage	<b>0.2 LF per sf of gross building area</b> (1 display parking space per 50 sf of building interior)										1.5%
Hardscape Ornamental Lighting Building Facades	<b>0.1 SF per SF of gross building area</b>		50%	50%	50%	25%		50%	25%	25%	5%
Outdoor Sales Lots	<b>30' building height, 2 floors per building</b> (20% of applicable facades are lit)		25%	50%	50%	25%		50%	25%	25%	5%
Vehicle Service Station Hardscape	<b>4 SF of sales lot per sf of gross building area</b> (1 display parking space per 50 sf of building interior)										1.5%
Vehicle Service Station Canopies	<b>1 SF per SF of gross building area</b>										1%
Sales Canopies	<b>1.2 SF of canopy per SF of gross building area</b>										1%
Non-sales Canopies	<b>0.1 SF of canopy per SF of gross building area</b>							25%	25%	25%	5%
Guard Stations	<b>0.1 SF of canopy per SF of gross building area</b>		25%	25%	25%	25%		25%	25%	25%	5%
Student Pick-up/Drop-off zone	<b>0.00043 sf per SF of gross building area</b> (1 12x18 guard station per 500,000 sf of total construction)		100%				100%			100%	100%
Outdoor Dining	<b>0.0173 sf per SF of gross building area</b> (1 12x72 drop off per 50,000 sf of total construction)								100%		
Special Security Lighting for Retail Parking and Pedestrian Hardscape	<b>1 sf per 5 sf of gross building area</b> (20% of typical building sf)			2.5%	50%	2.5%					
	<b>1 SF per 100 SF gross building SF</b> (1% of hardscape)			100%	100%	100%					50%

Most measure line items only apply to certain building types (retail or small office, for example).



**Table 6: Estimated New Nonresidential Construction in 2017 by Climate Zone and Building Type (Million Square Feet)**

New Construction Type	New Construction in 2017 (Million Square Feet)								
	Office, LG & SM	Retail	Restaurant	Food (grocery)	Warehouse, Ref & NR	Hotel	School	College	Other
Total (all climate zones)	41.085	29.218	5.729	7.784	25.685	10.301	9.852	6.57	49.924

The energy impacts per unit for each lighting zone for the Primary Entrances, Drive Up Windows, Outdoor Sales Frontage, Outdoor Sales Lots, Vehicle Service Station Hardscape, Non-sales Canopies, and Outdoor Dining are found in Table 7: Energy Impacts per Unit For all Lighting Zones below and were used to determine the first year potential statewide impacts of the new Reach Table 140.7-B.

**Table 7: Energy Impacts per Unit For all Lighting Zones**

Lighting Application	Per Unit First Year Savings by Lighting Zone <sup>1</sup>				
	Units	LZ1 Electricity Savings <sup>2</sup> (kWh/yr)	LZ2 Electricity Savings <sup>2</sup> (kWh/yr)	LZ3 Electricity Savings <sup>2</sup> (kWh/yr)	LZ4 Electricity Savings <sup>2</sup> (kWh/yr)
Primary Entrances	Each	117	188	281	57
Drive Up Windows	Each	34	120	223	343
Outdoor Sales Frontage	Per linear foot	N/A	15	21	29
Outdoor Sales Lots	Per Square Foot	0.22	1.1	0.89	0.98
Vehicle Service Station Hardscape	Per Square Foot	0.02	0.27	0.65	1.18
Non-sales Canopies	Per Square Foot	0.02	0.21	0.51	0.87
Outdoor Dining	Per Square Foot	0.01	0.06	0.14	0.31

<sup>1.</sup> Savings from one unit for the first year the site is in operation.

<sup>2.</sup> Site electricity savings. Does not include TDV of electricity savings.

Table 8: First Year Statewide Electricity Savings and First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B is a summary of the estimated potential statewide energy savings over the first twelve months of implementation of the Reach Table 140.7-B. Avoided greenhouse gas (GHG) emissions were calculated using a factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings.

Please note that these are potential savings assuming the Reach Table 140.7-B was adopted statewide instead of 2016 Table 140.7-B. Please see Appendix D for details on electricity savings and GHG emissions reductions that cities can expect by replacing their current (or 2016) Table 140.7-B with the new Reach Table 140.7-B.





**Table 8: First Year Statewide Electricity Savings and First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B**

	First Year and Total Measure Savings	
	First Year Electricity Savings (GWh)	First Year Statewide Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)
<b>Total</b>	10.96	3867.21

<sup>1</sup>. Avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings.



# Appendix B: COST-EFFECTIVENESS CALCULATIONS

---

This section provides the assumptions used to support the cost effectiveness analysis for the code adoption process. The Time Dependent Valuation (TDV) Energy Costs Savings are the present valued energy cost savings over the 15 year period of analysis using CEC's TDV methodology. The Total Incremental Cost represents the incremental initial construction and maintenance costs of the adopted measure relative to existing conditions (current minimally compliant construction practice). Costs incurred in the future (such as periodic maintenance costs or replacement costs) are discounted by a three percent real discount rate, per CEC's LCC Methodology.

The Benefit to Cost (B/C) Ratio is the incremental TDV Energy Costs Savings divided by the Total Incremental Costs. When the B/C ratio is greater than 1.0, the added cost of the measure is more than offset by the discounted energy cost savings and the measure is deemed to be cost effective. The total incremental cost is the total lifecycle cost of the LED system, including the present value of the maintenance costs over the measure life, minus the total lifecycle cost of the baseline system.

## Cost-effectiveness Summary

The present value (PV) of the energy savings were calculated using the method described in the LCC Methodology (CEC 2014). In short, the hourly energy savings estimates for the first year of building operation were multiplied by the 2016 TDV cost values to arrive at the PV of the cost savings over the 15 year period of analysis. This measure is not climate sensitive, so the hourly energy cost savings were calculated using the population-weighted TDV values.

The cost-effectiveness was calculated using the LCC Methodology (CEC 2014). According to CEC's definitions, a measure is cost effective if it reduces overall lifecycle cost from the current base case (existing conditions). The LCC Methodology clarifies that absolute lifecycle cost of the proposed measure does not need to be calculated. Rather, it is necessary to calculate the change in lifecycle cost from the existing conditions to the proposed conditions.

If the change in lifecycle cost is negative, the measure is cost-effective, meaning that the present value of TDV energy savings is greater than the cost premium.

The Benefit to Cost (B/C) Ratio is another metric that can be used to evaluate cost-effectiveness. The B/C Ratio is calculated by dividing the total present value TDV energy cost savings (the benefit) by the present value of the total incremental cost (the cost). If the B/C Ratio is greater than 1.0 (i.e. the present valued benefits are greater than the present valued costs over the period of analysis), then the measure is cost effective. Table 10: Reach Code Beyond 2016 Standards: Cost-effectiveness Summary<sup>1</sup> – Weighted Average Across Lighting Zones summarizes the cost-effectiveness of every line item in the new Reach Table 140.7-B and Table 11: Cost-effectiveness Summary<sup>1</sup> – Statewide Weighted Average Across Lighting Zones for all Measure Line-Items summarizes the overall cost-effectiveness of the entire measure.



**Table 9: Key Assumptions for per unit Incremental Construction Cost**

Parameter	Assumption	Source
Product Cost projections	LED costs are dropping rapidly	(DOE 2013) and manufacturer interviews for confirmation

**Table 10: Reach Code Beyond 2016 Standards: Cost-effectiveness Summary<sup>1</sup> – Weighted Average Across Lighting Zones**

Climate Zone	Units	Benefit: TDV Energy Cost Savings <sup>2</sup> (2017 PV\$)	Cost: Total Incremental Cost <sup>3</sup> (2017 PV\$)	Change in Lifecycle Cost <sup>4</sup> (2017 PV\$)	Benefit to Cost Ratio <sup>5</sup>
Primary Entrances	Each	407.73	Lower	-407.74	Infinite
Drive Up Windows	Each	380.43	148.00	-232.43	2.6
Outdoor Sales Frontage	Per linear foot	32.68	28.45	-4.23	1.1
Outdoor Sales Lots	Per Square Foot	1.61	0.29	-1.32	5.6
Vehicle Service Station Hardscape	Per Square Foot	1.05	0.04	-1.01	28.8
Non-sales Canopies	Per Square Foot	0.71	Lower	-0.71	Infinite
Outdoor Dining	Per Square Foot	0.21	Lower	-0.21	Infinite

1. Relative to existing conditions. All cost values presented in 2017 dollars.
2. Present value of TDV cost savings equals TDV electricity savings plus TDV natural gas savings;  $\Delta TDV\$ = \Delta TDV\$E + \Delta TDV\$G$ .
3. Total incremental cost equals incremental construction cost (post adoption) plus present value of incremental maintenance cost;  $\Delta C = \Delta CI_{PA} + \Delta CM$ .
4. Negative values indicate the measure is cost-effective (a reduction in the total lifecycle cost). Change in lifecycle cost equals cost premium minus TDV energy cost savings;  $\Delta LCC = \Delta C - \Delta TDV\$$
5. The benefit to cost ratio is the TDV energy costs savings divided by the total incremental costs;  $B/C = \Delta TDV\$ \div \Delta C$ . The measure is cost effective if the B/C ratio is greater than 1.0.



**Table 11: Cost-effectiveness Summary<sup>1</sup> – Statewide Weighted Average Across Lighting Zones for all Measure Line-Items**

Climate Zone	Units	Benefit: TDV Energy Cost Savings <sup>2</sup> (2017 PV\$)	Cost: Total Incremental Cost <sup>3</sup> (2017 PV\$)	Change in Lifecycle Cost <sup>4</sup> (2017 PV\$)	Benefit to Cost Ratio <sup>5</sup>
Reach Table 140.7-B (entire measure)	Per Square Foot	1.47	0.44	-1.03	3.33

1. Relative to existing conditions. All cost values presented in 2017 dollars. “Hospital” building category exclude from cost and savings projections.
2. Present value of TDV cost savings equals TDV electricity savings plus TDV natural gas savings;  $\Delta TDV\$ = \Delta TDV\$E + \Delta TDV\$G$ .
3. Total incremental cost equals incremental construction cost (post adoption) plus present value of incremental maintenance cost;  $\Delta C = \Delta CI_{PA} + \Delta CM$ .
4. Negative values indicate the measure is cost-effective. Change in lifecycle cost equals cost premium minus TDV energy cost savings;  $\Delta LCC = \Delta C - \Delta TDV\$$
5. The benefit to cost ratio is the TDV energy costs savings divided by the total incremental costs;  $B/C = \Delta TDV\$ \div \Delta C$ . The measure is cost effective if the B/C ratio is greater than 1.0.



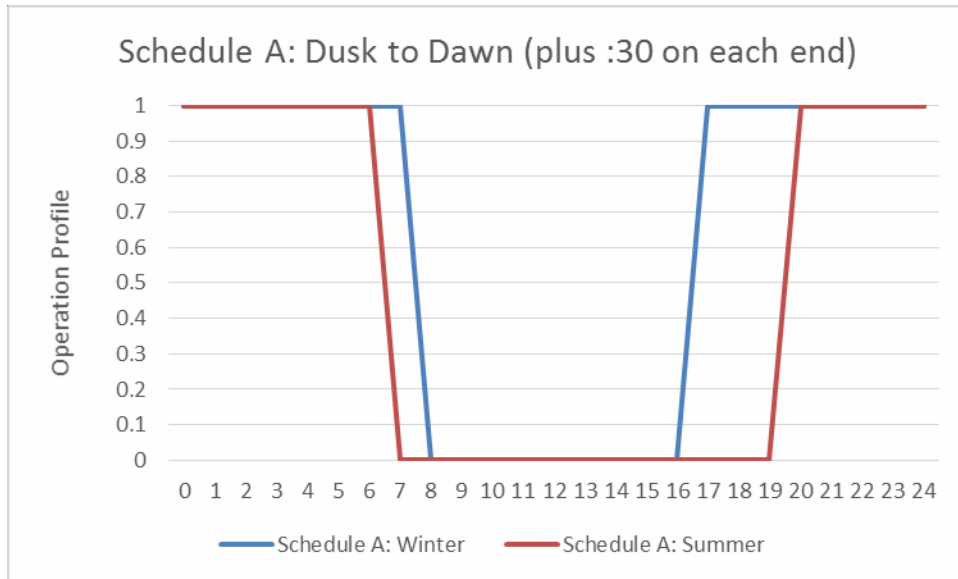
# Appendix C: LIGHTING USE PROFILES

The following lighting schedules were used to determine the amount of time outdoor lights would be on for a year.

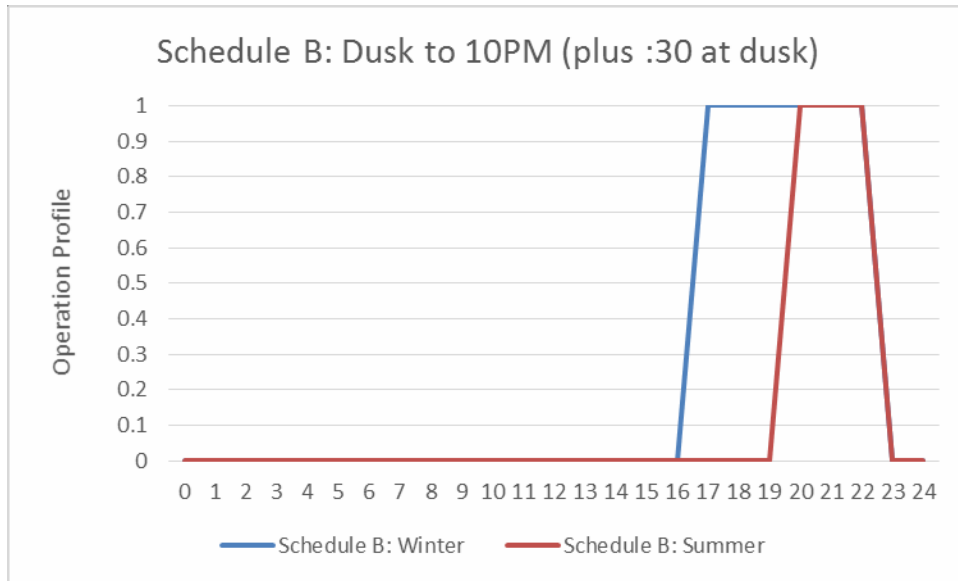
**Figure 2: Lighting Application Schedule Use Matrix**

Lighting Application	Use Schedule Applied
Primary Entrances	Schedule A
Drive Up Windows	Retail Lighting
Outdoor Sales Frontage	Schedule C
Outdoor Sales Lots	Retail Lighting
Vehicle Service Station Hardscape	Service Station Hardscape
Non-sales Canopies	Schedule A
Outdoor Dining	Schedule B

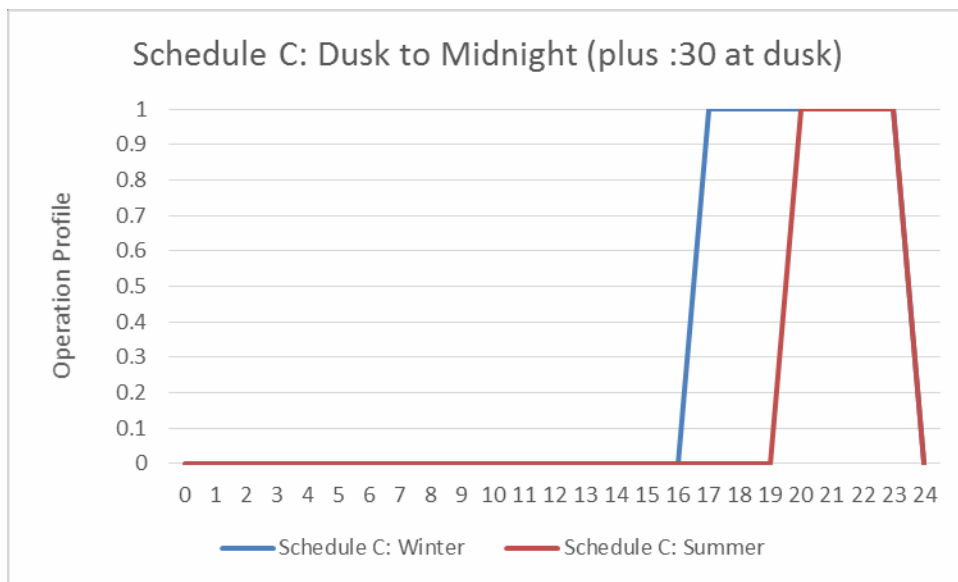
**Figure 3: Schedule A: Winter and Summer Curves**



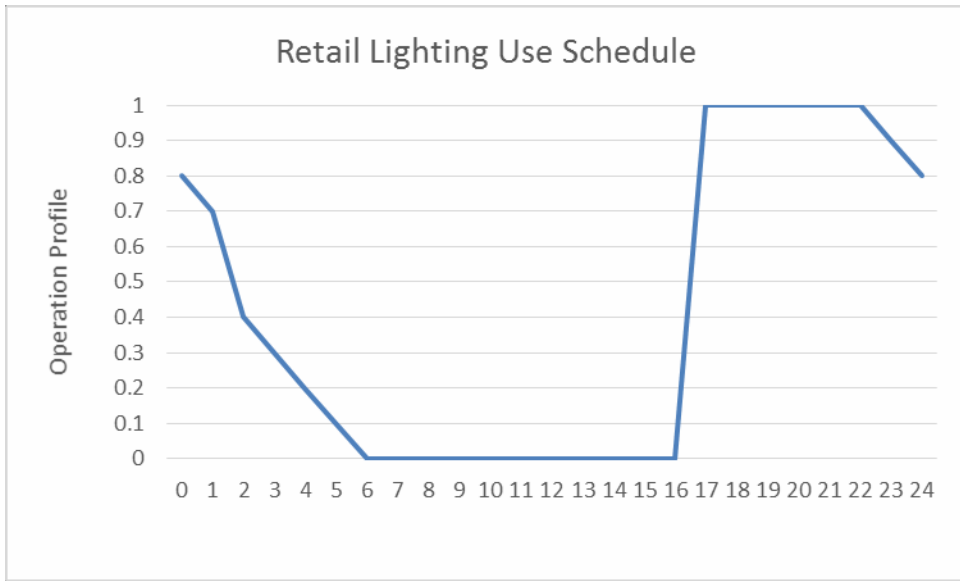
**Figure 4: Schedule B: Winter and Summer Curves**



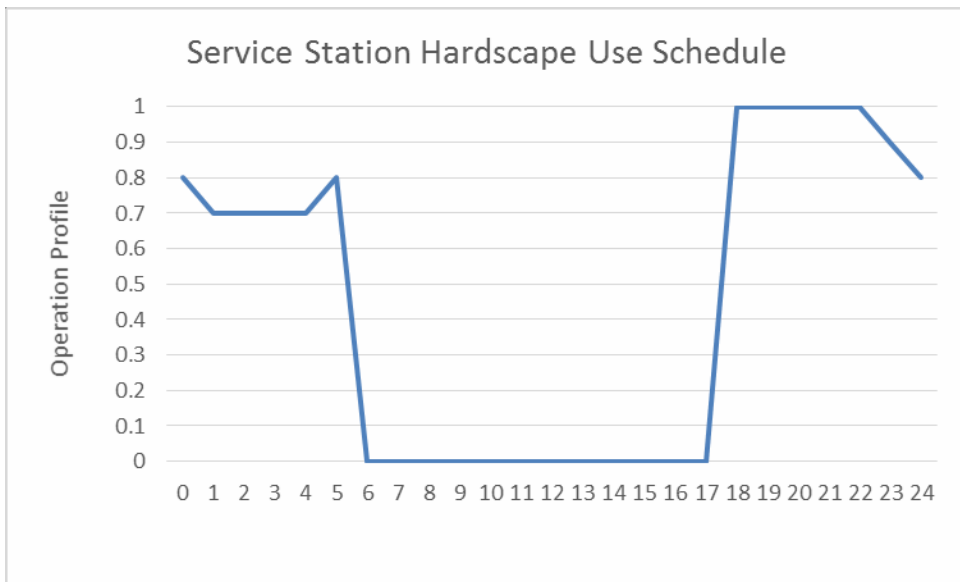
**Figure 5: Schedule C: Winter and Summer Curves**



**Figure 6: Retail Lighting Use Schedule**



**Figure 7: Service Station Hardscape Use Schedule**



## Appendix D: ENERGY SAVINGS FOR CITIES

Individual local governments that adopt the new Reach Table 140.7-B, should expect to see different energy savings and GHG emissions reductions based on size of their city. The following tables summarize estimated first year energy savings and GHG emissions reductions for a few example cities. Energy savings and GHG emissions reductions were also calculated over the 15 year period of analysis used for cost-effectiveness calculations. These savings estimates include three years of early installation (2017, 2018, and 2019) and the 15 year period of analysis. For the purpose of this report these savings are referred to as Total Lifecycle Measure Savings. Please see Section 5.3 for more information on cost-effectiveness. Please note that these savings only account for new construction and do not include alterations or retrofits.

### City A: Population 850,000

**Table 12: City A Estimated First Year and Total Measure Savings<sup>4</sup> for Reach Table 140.7-B**

	First Year and Total Measure Savings		
	First Year Electricity Savings (GWh)	Total Measure Savings (GWh)	Peak Demand Reduction (MW)
<b>Total</b>	0.24	10.80	N/A

**Table 13: City A First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B**

	First Year Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)	Total Measure Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)
<b>Total</b>	84.72	3,812

<sup>1</sup>. Avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings.

<sup>4</sup> Total Measure Savings is calculated as the savings achieved from all forecasted installations in a city of a given size between 2017-2019, and over a 15 year period of analysis for those installations.





## City B: Population 500,000

**Table 14: City B Estimated First Year and Total Measure Savings<sup>5</sup> for Reach Table 140.7-B**

	First Year and Total Measure Savings		
	First Year Electricity Savings (GWh)	Total Measure Savings (GWh)	Peak Demand Reduction (MW)
<b>Total</b>	0.14	6.35	N/A

**Table 15: City B First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B**

	First Year Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)	Total Measure Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)
<b>Total</b>	49.84	2,243

<sup>1</sup>. Avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings.

## City C: Population 100,000

**Table 16: City C Estimated First Year and Total Measure Savings<sup>6</sup> for Reach Table 140.7-B**

	First Year and Total Measure Savings		
	First Year Electricity Savings (GWh)	Total Measure Savings (GWh)	Peak Demand Reduction (MW)
<b>Total</b>	0.03	1.27	N/A

**Table 17: City C First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B**

	First Year Statewide Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)	Total Measure Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2e</sub> /yr)
<b>Total</b>	9.97	449

<sup>1</sup>. Avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2e</sub>) per GWh of electricity savings.

<sup>5</sup> Total Measure Savings is calculated as the savings achieved from all forecasted installations in a city of a given size between 2017-2019, and over a 15 year period of analysis for those installations.

<sup>6</sup> “ ”



## City D: Population 50,000

**Table 18: City D Estimated First Year and Total Measure Savings<sup>7</sup> for Reach Table 140.7-B**

	First Year and Total Measure Savings		
	First Year Electricity Savings (GWh)	Total Measure Savings (GWh)	Peak Demand Reduction (MW)
<b>Total</b>	0.01	0.64	N/A

**Table 19: City D First Year and Total Measure Greenhouse Gas Emissions Impacts for Reach Table 140.7-B**

	First Year Statewide Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2</sub> e/yr)	Total Measure Avoided GHG Emissions <sup>1</sup> (MTCO <sub>2</sub> e/yr)
<b>Total</b>	4.98	224

<sup>1.</sup> Avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents (MTCO<sub>2</sub>e) per GWh of electricity savings.

---

<sup>7</sup>Total Measure Savings is calculated as the savings achieved from all forecasted installations in a city of a given size between 2017-2019, and over a 15 year period of analysis for those installations.



# Appendix E: AVAILABLE LUMINAIRES CAPABLE OF MEETING REACH TABLE 140.7-B REQUIREMENTS

There are a number of luminaires available on the market that can be used to satisfy the new Reach Table 140.7-B requirements.

Table 20: Available luminaires that meet new Reach Table 140.7-B. below lists the luminaires that were used to calculate cost-effectiveness for the Reach Table 140.7-B. All of the listed luminaires are medium to low priced. The last column, "Location(s)," describes which specific line item from Table 140.7-B each luminaire satisfies.

**Table 20: Available luminaires that meet new Reach Table 140.7-B.**

Luminaire Type	Manufacturer	Luminaire	2016 Catalogue Number	Location(s)
Area	Cree	ARE	ARE-EHO/4MB/HV/24/E/UL/BK/700/40K-DIM	Outdoor Sales Frontage, Outdoor Sales Lots
Area	Cree	ARE	ARE-EHO/4MB/HV/24/E/UL/BK/1000/40K-DIM	Outdoor Sales Frontage, Outdoor Sales Lots
Flood	Cree	FLD-N6	FLD-EHO/N6/HV/12/E/UL/BK/700/40K-DIM	Outdoor Sales Frontage
Flood	Cree	FLD-N6	FLD-EHO/N6/HV/24/E/UL/BK/700/40K-DIM	Outdoor Sales Frontage
Flood	Cree	FLD-N6	FLD-EHO/N6/HV/24/E/UL/BK/1000/40K-DIM	Outdoor Sales Frontage
Area	Luminis	SR620	SR620/L1W30/120/BKT/PH/APA	Primary Entrances
Area	GE	Evolve	ERS20/16/E1-X/40/A/BLCK/G-L	Outdoor Sales Frontage, Outdoor Sales Lots
Area	GE	Evolve	ERS20/18/E1-X/40/A/BLCK/G-L	Outdoor Sales Frontage, Outdoor Sales Lots
String Light	GE †	LED4G16	LED4DG16C-W/TP	Outdoor Dining
Area	Cooper	AVS	AVS/F01/LED/E/U/SL4/BK/CPR/U/2L/OA/RA1016	Primary Entrances, Vehicle Service Station Hardscape
Area	Cooper	AVS	AVS/E01/LED/E/U/SL4/BK/CPR/U/2L/OA/RA1016	Primary Entrances, Vehicle Service Station Hardscape
Area	Cooper	AVS	AVS/F02/LED/E/U/SL4/BK/CPR/U/2L/OA/RA1016	Vehicle Service Station Hardscape
Downlight	Cooper	LD8	LD8A-40-1-D010TE-ER8A40835-8LM1-LI	Non-sales Canopies



Round Ceiling Mounted Downlight	Cooper	VPL	VPL/F01/LED/E1/GL4/BK/DI M/SM	Drive Up Windows
Round Ceiling Mounted Downlight	Cooper	VPL	VPL/F02/LED/E1/GL4/BK/DI M/SM	Drive Up Windows
Round Ceiling Mounted Downlight	Cooper	VPL	VPL/E04/LED/E1/GL4/BK/DI M/SM	Drive Up Windows
Flood	Beacon	AL	AL-D/36NB-80/4K/5X5/UNV/PCR-TL/SF3//BMT	Outdoor Sales Frontage
Flood	Beacon	AL	AL-D/72NB-170/4K/5X5/UNV/PCR-TL/SF3//BMT	Outdoor Sales Frontage
Downlight	Prescolite	MD8	MD8LED-6L-35K-8-8MD-6L-WFL45-SL	Primary Entrances
Downlight	Prescolite	MD8	MD8LED-9L-35K-8-8MD-9L-WFL45-SL	Non-sales Canopies
Downlight	Gotham	EVO	EVO-35/07-4AR-MD-LS-120	Non-sales Canopies
Downlight	Gotham	EVO	EVO-35/10-4AR-MD-LS-120	Non-sales Canopies
Downlight	Gotham	EVO	EVO-35/20-6AR-MD-LS-120	Drive Up Windows, Non-sales Canopies
Downlight	Gotham	EVO	EVO-35/20-4AR-MD-LS-120	Non-sales Canopies
Downlight	Gotham	EVO	EVO-35/20-8AR-MD-LS-120	Drive Up Windows
Downlight	Gotham	EVO	EVO-35/20-8AR-MD-LS-120	Primary Entrances, Drive Up Windows
Downlight	Gotham	EVO	EVO-35/30-8AR-MD-LS-120	Primary Entrances, Drive Up Windows, Non-sales Canopies
Flood	Hydrel	8100	8100/P2/40K/MFL/YM/PMT/P E/LPI/BL	Outdoor Sales Frontage
Gasket Linear Fluorescent	Lithonia	FEM	FEM4 LED/3L/35/IMACD/CS89/DI M/WLF	Non-sales Canopies
Gasket Linear Fluorescent	Lithonia	FEM	FEM4 LED/4L/35/IMACD/CS89/DI M/WLF	Non-sales Canopies
Gasket Linear Fluorescent	Lithonia	VAP	VAP/4000LM/FST/MD/MVO LT/GZ10/35K/80	Non-sales Canopies
Gasket Linear Fluorescent	Lithonia	VAP	VAP/6000LM/FST/MD/MVO LT/GZ10/35K/80	Non-sales Canopies
Wall Pack	Lithonia	WSTM	WSTM	Primary Entrances



			LED/1A/40K/120/PE/DBLXD	
Wall Pack	Lithonia	WSTM	WSTM LED/2A/40K/120/PE/DBLXD	Primary Entrances
Recessed Linear Fluorescent	Selux	M100 04	L1R1-1A35-35-LW-TB-04- WH-120	Non-sales Canopies
Recessed Linear Fluorescent	Selux	M125 (2)03	L125-2L35-40-SD-F-003-WH- 120	Non-sales Canopies
Recessed Linear Fluorescent	Selux	M125 (2)04	L125-2L35-40-SD-F-004-WH- 120	Non-sales Canopies
Recessed Linear Fluorescent	Selux	M125 03	L125-1L35-40-SD-F-003-WH- 120	Non-sales Canopies
Recessed Linear Fluorescent	Selux	M36 03	L36-1A25-35-LW-F2-03-WH- 120	Non-sales Canopies
Recessed Linear Fluorescent	Selux	M36 04	L36-1A25-35-LW-F2-04-WH- 120	Non-sales Canopies
Recessed Linear Fluorescent	Selux	M60 03	L60-1A35-35-LW-F-03-WH- 120	Non-sales Canopies
Downlight	WE-EF	630	630-4354/DOC220-LED	Drive Up Windows
String Light	Ushio	Utopia CA10	1003858	Outdoor Dining
String Light	Ushio	Utopia G16.5	1003930	Outdoor Dining
Wall Pack	Gardco	101	101L- DIM/4/35LA/NW/UNIV/BLP/ PCB	Primary Entrances
Wall Pack	Gardco	111	no lower lumen output exists	Primary Entrances
Wall Pack	Gardco	111	111L- DIM/4/30LA/NW/UNIV/BLP/ PCB	Primary Entrances
Wall Pack	Gardco	Form 10	WE14L/1/4/70LA/NW/UNIV/ BLA/PC	Primary Entrances
Wall Pack	Gardco	Form 10	WE14L/1/4/85LA/NW/UNIV/ BLA/PC	Primary Entrances
Flood	Gardco	FX2	FX/80/T/A/M/N/A/5/E/N/S	Outdoor Sales Frontage
Flood	Gardco	FX2	FX/160/T/A/M/N/A/5/E/N/S	Outdoor Sales Frontage
Ceiling Mounted Box	Gardco	SFC	No lower lumen outputs exist	Drive Up Windows
Round Ceiling Mounted	Gardco	SFC	SFC- DIM/5W/55LA/NW/UNIV/NP /PCB	Drive Up Windows



Downlight				
Ceiling Mounted Box	Gardco	SFC	SFC-DIM/5W/80LA/NW/UNIV/NP/PCB	Drive Up Windows
Ceiling Mounted Box	Gardco	SFC	SFC-DIM/5W/105LA/NW/UNIV/NP/PCB	Drive Up Windows
Area	Gardco	SFRA	SFRA-DIM-1-4-25LA-4135-NW-UNV-AR-BLP-PC	Vehicle Service Station Hardscape
Area	Gardco	SFRA	SFRA-DIM-1-4-55LA-4835-NW-UNV-AR-BLP-PC	Vehicle Service Station Hardscape, Outdoor Sales Frontage, Outdoor Sales Lots
Area	Gardco	SFRA	SFRA-DIM-1-4-90LA-8035-NW-UNV-AR-BLP-PC	Vehicle Service Station Hardscape, Outdoor Sales Frontage, Outdoor Sales Lots
Area	Gardco	SFRA	SFRA-DIM-1-4-110LA-4870-NW-UNV-AR-BLP-PC	Vehicle Service Station Hardscape, Outdoor Sales Frontage, Outdoor Sales Lots
Area	Gardco	SFRA	SFRA-DIM-1-4-130LA-8053-NW-UNV-AR-BLP-PC	Vehicle Service Station Hardscape, Outdoor Sales Frontage, Outdoor Sales Lots
Area	Gardco	Slender	SFA-DIM/1/4/30LA/NW/UNIV/BLP/PC	Primary Entrances
Area	Gardco	Slender	SFA-DIM/1/4/30LA/NW/UNIV/BLP/PC	Primary Entrances
Area	Gardco	Slender	SFA-DIM/1/4/80LA/NW/UNIV/BLP/PC	Primary Entrances
Area	Gardco	Slender	SFA-DIM/1/4/130LA/NW/UNIV/BLP/PC	Primary Entrances
Wall Pack	Philips	161	161-DIM/4/150LA-6470/NW/UNIV/BLP/PCB/DL	Primary Entrances
Downlight	Philips	C7L	C7L-50-DL-35K/M/CL/W/VB (Housing: C7L50N2VBZ10V)	Primary Entrances
Gasket Linear Fluorescent	Philips	LPL	LPL/R/4L30/35K/UNV/F1/BK	Non-sales Canopies
Gasket Linear Fluorescent	Philips	LPL	LPL/R/2L30/35K/UNV/F1/BK	Non-sales Canopies
String Light	Lifebulb		PLT-10116	Outdoor Dining
String Light	Lifebulb		PLT-10114	Outdoor Dining



String Light	Green Creative		57886 LED	Outdoor Dining
String Light	Polaroid		PLB10E12-40.300.5.7D	Outdoor Dining
String Light	Sylvania		79634	Outdoor Dining
String Light	Archipelago		LG16526C24027K3	Outdoor Dining

† Available since 2014



# Appendix F REACH TABLE 140.7-B

Table 140.7-B ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
<b>WATTAGE ALLOWANCE PER APPLICATION.</b> Use all that apply as appropriate.					
<b>Building Entrances or Exits.</b> Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not Applicable	15 watts	25 watts	35 watts	45 watts
<b>Primary Entrances to Senior Care Facilities, Police Stations, Hospitals, Fire Stations, and Emergency Vehicle Facilities.</b> Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not Applicable	20 watts	40 watts	60 watts	80 watts
<b>Drive Up Windows.</b> Allowance per customer service location. Luminaires qualifying for this allowance shall be within 2 mounting heights of the sill of the window.	Not Applicable	30 watts	40 watts	60 watts	100 watts
<b>Vehicle Service Station Uncovered Fuel Dispenser.</b> Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within 2 mounting heights of the dispenser.	Not Applicable	120 watts	175 watts	185 watts	330 watts
<b>ATM Machine Lighting.</b> Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not Applicable	250 watts for first ATM machine, 70 watts for each additional ATM machine			
<b>WATTAGE ALLOWANCE PER UNIT LENGTH (w/linear ft).</b> May be used for one or two frontage side(s) per site.					
<b>Outdoor Sales Frontage.</b> Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	Not Applicable	No Allowance	15 W/linear ft	25 W/linear ft	30 W/linear ft
<b>WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft<sup>2</sup>).</b> May be used for any illuminated hardscape area on the site.					
<b>Hardscape Ornamental Lighting.</b> Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 100 watts or less as determined in accordance with Section 130.0(d), and shall be post- top luminaires, lanterns, pendant luminaires, or chandeliers.	Not Applicable	No Allowance	0.02 W/ft <sup>2</sup>	0.04 W/ft <sup>2</sup>	0.06 W/ft <sup>2</sup>
<b>WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft<sup>2</sup>).</b> Use as appropriate provided that none of the following specific applications shall be used for the same area.					
<b>Building Facades.</b> Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.	Not Applicable	No Allowance	0.18 W/ft <sup>2</sup>	0.35 W/ft <sup>2</sup>	0.50 W/ft <sup>2</sup>





Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
<b>Outdoor Sales Lots.</b> Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non-sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.	Not Applicable	0.100 W/ft <sup>2</sup>	0.250 W/ft <sup>2</sup>	0.500 W/ft <sup>2</sup>	1.000 W/ft <sup>2</sup>
<b>Vehicle Service Station Hardscape.</b> Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	Not Applicable	0.010 W/ft <sup>2</sup>	0.100 W/ft <sup>2</sup>	0.150 W/ft <sup>2</sup>	0.200 W/ft <sup>2</sup>
<b>Vehicle Service Station Canopies.</b> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not Applicable	0.514 W/ft <sup>2</sup>	1.005 W/ft <sup>2</sup>	1.300 W/ft <sup>2</sup>	2.200 W/ft <sup>2</sup>
<b>Sales Canopies.</b> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not Applicable	No Allowance	0.655 W/ft <sup>2</sup>	0.908 W/ft <sup>2</sup>	1.135 W/ft <sup>2</sup>
<b>Non-sales Canopies and Tunnels.</b> Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not Applicable	0.080 W/ft <sup>2</sup>	0.160 W/ft <sup>2</sup>	0.300 W/ft <sup>2</sup>	0.400 W/ft <sup>2</sup>
<b>Guard Stations.</b> Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within 2 mounting heights of a vehicle lane or the guardhouse.	Not Applicable	0.154 W/ft <sup>2</sup>	0.355 W/ft <sup>2</sup>	0.708 W/ft <sup>2</sup>	0.985 W/ft <sup>2</sup>
<b>Student Pick-up/Drop-off zone.</b> Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within 2 mounting heights of the student pick-up/drop-off zone.	Not Applicable	No Allowance	0.12 W/ft <sup>2</sup>	0.45 W/ft <sup>2</sup>	No Allowance
<b>Outdoor Dining.</b> Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within 2 mounting heights of the hardscape area of outdoor dining.	Not Applicable	0.010 W/ft <sup>2</sup>	0.100 W/ft <sup>2</sup>	0.150 W/ft <sup>2</sup>	0.200 W/ft <sup>2</sup>
<b>Special Security Lighting for Retail Parking and Pedestrian Hardscape.</b> This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not Applicable	0.007 W/ft <sup>2</sup>	0.009 W/ft <sup>2</sup>	0.019 W/ft <sup>2</sup>	No Allowance

