CALIFORNIA STATEWIDE
UTILITY CODES AND STANDARDS PROGRAM

2019 Title 24 Codes & Standards Enhancement (CASE) Proposal

Nonresidential Outdoor Lighting Power Allowances

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Nancy Clanton (nancy@clantonassociates.com)
Annie Kuczkowski (annie@clantonassociates.com)
Mike McGaraghan (mmcgaraghan@energy-solution.com)
Chris Uraine (curaine@energy-solution.com)

Proposed Code Change Overview

- Revise light power allowances for nonresidential outdoor lighting
  - Tables 140.7-A and 140.7-B
- Building system impacted
  - All nonresidential exterior lighting
- Anticipated prescriptive change
- Description of change
  - Use LED as basis for all exterior calculated LPAs
  - Build on 2016 Outdoor LPA CASE Study and propose new LPA requirements
  - No philosophical change to design criteria matrix as established in 2005 code revision cycle
  - New LPAs that can be met with 3000K LEDs

Outdoor Lighting Code Change History

- During development of 2016 Standards (in 2013) outdoor lighting market in transition.
  - Less stable info on performance and cost
  - RP-20 is not an ANSI document, illuminance levels were not open for public comment
  - New LPAs will be calculated with RP-20-16 if updated in time
- Table 140.7-A (hardscape) partially updated
  - LPA's could be lower and concrete allowances inserted as a footnote
- Table 140.7-B (specific applications) mostly unchanged since 2008
- Rapid LED efficiency advancements and declining costs

Current Code Requirements

- Table 140.7-A General Hardscape
  - General allowance values apply to all outdoor spaces
  - Better to have separate columns for concrete lots instead of large footnote (RP-20-14)

TABLE 140.7-A GENERAL HARDSCAPE LIGHTING POWER ALLOWANCE

Type of Power Allowance	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2[2]	Lighting Zone 3[2]	Lighting Zone 4
Area Wattage Allowance (AWA)	No Allowance [1]	0.020 W/ft^2	0.030 W/ft^2	0.040 W/ft^2	0.050 W/ft^2
Linear Wattage Allowance (LWA)		0.15 W/lf	0.25 W/lf	0.35 W/lf	0.45 W/lf
Initial Wattage Allowance (IWA)		340 W	450 W	520 W	640 W

[1] Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 Watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse, or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed in Lighting Zone 0 shall meet the maximum zonal lumen limits for Uplight and Glare specified in Table 130.2-A and 130.2-B.

[2] For Lighting Zone 2 and 3, where greater than 50% of the paved surface of a parking lot is finished with concrete, the AWA for that area shall be 0.035 W/ft^2 for Lighting Zone 2 and 0.040 W/ft^2 for Lighting Zone 3, and the LWA for both lighting zones shall be 0.70 W/lf. This does not extend beyond the parking lot, and does not include any other General Hardscape areas.

Current Code Requirements

- Table 140.7-A General Hardscape
  - General allowance values apply to all outdoor spaces
  - Better to have separate columns for concrete lots instead of large footnote

Proposed Table 140.7-A (separate columns for asphalt and concrete)

TABLE 140.7-A GENERAL HARDSCAPE LIGHTING POWER ALLOWANCE

Type of Power Allowance	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2		Lighting Zone 3		Lighting Zone 4
	Asphalt/Concrete	Asphalt/Concrete	Asphalt	Concrete[2]	Asphalt	Concrete[2]	Asphalt/Concrete
Area Wattage Allowance (AWA)	No Allowance [1]	0.020 W/ft^2	0.030 W/ft^2	0.035 W/ft^2	0.040 W/ft^2	0.040 W/ft^2	0.050 W/ft^2
Linear Wattage Allowance (LWA)		0.15 W/lf	0.25 W/lf	0.70 W/lf	0.35 W/lf	0.70 W/lf	0.45 W/lf
Initial Wattage Allowance (IWA)		340 W	450 W	450 W	520 W	520 W	640 W

[1] Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 Watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse, or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed in Lighting Zone 0 shall meet the maximum zonal lumen limits for Uplight and Glare specified in Table 130.2-A and 130.2-B.

[2] Where greater than 50% of the paved surface of a parking lot is finished with concrete. This does not extend beyond the parking lot, and does not include any other General Hardscape areas.

IES guidelines as basis of Illuminance Criteria

Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Hardscape	IES RP-20-14 "Parking lot - Pre-curfew" Asphalt 0.5 HFC Min, 4:1 Avg:Min Asphalt 0.25 VFC Min, 4:1 Avg:Min Concrete 1.0 HFC Min, 4:1 Avg:Min Concrete 0.5 VHF Min, 4:1 Avg:Min				
Building Entrances or Exits	IES Handbook 10th Edition Table 22.2 "Non-Covered Entries/Exits"				
	Low Activity LZ0 1.0 HFC AVG 0.1 VFC AVG	Medium Activity LZ1 1.0 HFC Avg, 2:1 Avg:Min 0.4 VFC Avg, 4:1 Avg:Min	Medium Activity LZ2 1.0 HFC Avg, 2:1 Avg:Min 0.6 VFC Avg, 4:1 Avg:Min	Medium Activity LZ3 1.0 HFC Avg, 2:1 Avg:Min 0.8 VFC Avg, 4:1 Avg:Min	Medium Activity LZ4 1.0 HFC Avg, 2:1 Avg:Min 1.0 VFC Avg, 2:1 Avg:Min
Primary Entrances	IES Handbook 10th Edition Table 22.2 "Canopied Building Entries >65 years"				
	n/a	High Activity LZ1 3.0 HFC Avg, 2:1 Avg:Min 1.6 VFC Avg, 4:1 Avg:Min	High Activity LZ2 4.0 HFC Avg, 2:1 Avg:Min 2.0 VFC Avg, 4:1 Avg:Min	High Activity LZ3 6.0 HFC Avg, 2:1 Avg:Min 3.0 VFC Avg, 4:1 Avg:Min	High Activity LZ4 8.0 HFC Avg, 2:1 Avg:Min 4.0 VFC Avg, 2:1 Avg:Min
Drive up Windows	IES Handbook 10th Edition Table 31.2 "Drive-Up Financial Services"				
	n/a	Covered LZ1 2.0 HFC Avg, 3:1 Avg:Min 3.0 VFC Avg, 6:1 Avg:Min	Covered LZ2 3.0 HFC Avg, 3:1 Avg:Min 4.0 VFC Avg, 6:1 Avg:Min	Covered LZ3 4.0 HFC Avg, 3:1 Avg:Min 5.0 VFC Avg, 6:1 Avg:Min	Covered LZ4 5.0 HFC Avg, 3:1 Avg:Min 7.5 VFC Avg, 3:1 Avg:Min
Vehicle Service Station Uncovered Fuel Dispenser	IES Handbook 10th Edition Table 34.2 "Service Stations Dispensing Island"				
	n/a	Medium Activity LZ1 5.0 HFC Avg, 4:1 Avg:Min 5.0 VFC Avg, 8:1 Avg:Min	Medium Activity LZ2 7.5 HFC Avg, 4:1 Avg:Min 7.5 VFC Avg, 8:1 Avg:Min	Medium Activity LZ3 10.0 HFC Avg, 4:1 Avg:Min 10.0 VFC Avg, 8:1 Avg:Min	Medium Activity LZ4 15.0 HFC Avg, 4:1 Avg:Min 15.0 VFC Avg, 4:1 Avg:Min
ATM Machine Lighting	California Financial Code 13040-13041 10.0 HFC Min within 5ft 2.0 HFC Min within 60ft 10.0 VFC Min on machine face				

Table 140.7-B Specific Applications

Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Outdoor Sales Frontage	IES Handbook 10th Edition Table 34.2 "Automotive Sales Front Row"				
	n/a	Medium Activity LZ1 7.5 HFC Avg, 3:1 Avg:Min 7.5 VFC Avg, 6:1 Avg:Min	Medium Activity LZ2 10.0 HFC Avg, 3:1 Avg:Min 10.0 VFC Avg, 6:1 Avg:Min	Medium Activity LZ3 15.0 HFC Avg, 3:1 Avg:Min 15.0 VFC Avg, 6:1 Avg:Min	Medium Activity LZ4 20.0 HFC Avg, 3:1 Avg:Min 20.0 VFC Avg, 3:1 Avg:Min
Hardscape Ornamental Lighting	n/a				
Building Facades	IES Handbook 10th Edition Table 26.2 "Façade Fields, >50% Reflectance"				
	n/a	Medium Activity LZ1 1.5 FC Avg	Medium Activity LZ2 2.0 FC Avg	Medium Activity LZ3 3.0 FC Avg	Medium Activity LZ4 4.0 FC Avg
Outdoor Sales Lots	IES Handbook 10th Edition Table 34.2 "Automotive Sales"				
	n/a	Medium Activity LZ1 5.0 HFC Avg, 3:1 Max:Min 3.0 VFC Avg, 6:1 Max:Min	Medium Activity LZ2 7.5 HFC Avg, 3:1 Max:Min 4.0 VFC Avg, 6:1 Max:Min	Medium Activity LZ3 10.0 HFC Avg, 3:1 Max:Min 5.0 VFC Avg, 6:1 Max:Min	Medium Activity LZ4 15.0 HFC Avg, 3:1 Max:Min 7.5 VFC Avg, 3:1 Max:Min
Vehicle Service Station Hardscape	IES Handbook 10th Edition Table 34.2 "Service Stations Outdoor Service"				
	n/a	Medium Activity LZ1 1.5 HFC Avg, 2:1 Avg:Min 1.5 VFC Avg, 4:1 Avg:Min	Medium Activity LZ2 2.0 HFC Avg, 2:1 Avg:Min 2.0 VFC Avg, 4:1 Avg:Min	Medium Activity LZ3 3.0 HFC Avg, 2:1 Avg:Min 3.0 VFC Avg, 4:1 Avg:Min	Medium Activity LZ4 4.0 HFC Avg, 2:1 Avg:Min 4.0 VFC Avg, 2:1 Avg:Min
Vehicle Service Station Canopies	IES Handbook 10th Edition Table 34.2 "Service Stations Dispensing Islands"				
	n/a	Medium Activity LZ1 5.0 HFC Avg, 4:1 Avg:Min 5.0 VFC Avg, 8:1 Avg:Min	Medium Activity LZ2 7.5 HFC Avg, 4:1 Avg:Min 7.5 VFC Avg, 8:1 Avg:Min	Medium Activity LZ3 10.0 HFC Avg, 4:1 Avg:Min 10.0 VFC Avg, 8:1 Avg:Min	Medium Activity LZ4 15.0 HFC Avg, 4:1 Avg:Min 15.0 VFC Avg, 4:1 Avg:Min

Table 140.7-B Specific Applications

Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Sales Canopies	IES Handbook 10th Edition Table 34.2 "Seasonal Open-Air Merchandise"				
	n/a	LZ1 1.5 HFC Avg, 2:1 Avg:Min 1.5 VFC Avg, 4:1 Avg:Min	LZ2 1.0 HFC Avg, 2:1 Avg:Min 0.6 VFC Avg, 4:1 Avg:Min	LZ3 3.0 HFC Avg, 2:1 Avg:Min 3.0 VFC Avg, 4:1 Avg:Min	LZ4 4.0 HFC Avg, 2:1 Avg:Min 4.0 VFC Avg, 2:1 Avg:Min
Non-sales Canopies and Tunnels	IES Handbook 10th Edition Table 22.2 "Canopied Entries"				
	Low Activity LZ0 0.2 HFC Avg, 2:1 Avg:Min 0 VFC Avg	Medium Activity LZ1 0.8 HFC Avg, 2:1 Avg:Min 0.4 VFC Avg, 4:1 Avg:Min	Medium Activity LZ2 1.0 HFC Avg, 2:1 Avg:Min 0.6 VFC Avg, 4:1 Avg:Min	Medium Activity LZ3 1.5 HFC Avg, 2:1 Avg:Min 0.8 VFC Avg, 4:1 Avg:Min	Medium Activity LZ4 2.0 HFC Avg, 2:1 Avg:Min 1.0 VFC Avg, 2:1 Avg:Min
Guard Stations	IES Handbook 10th Edition Table 22.2 "Remote Monitored Site Gated Entries"				
	Vehicles LZ0 0.8 HFC Avg, 2:1 Avg:Min 0.6 VFC Avg, 4:1 Avg:Min	Vehicles LZ1 1.0 HFC Avg, 2:1 Avg:Min 0.8 VFC Avg, 4:1 Avg:Min	Vehicles LZ2 1.5 HFC Avg, 2:1 Avg:Min 1.0 VFC Avg, 4:1 Avg:Min	Vehicles LZ3 2.0 HFC Avg, 2:1 Avg:Min 1.5 VFC Avg, 4:1 Avg:Min	Vehicles LZ4 3.0 HFC Avg, 2:1 Avg:Min 2.0 VFC Avg, 2:1 Avg:Min
Student Pick-up/ Drop-off Zone	IES Handbook 10th Edition Table 36.2 "Aviation Terminals Covered Bus and Shuttle Pick-up/Drop Off"				
	n/a	Medium Activity LZ1 0.8 HFC Avg, 2:1 Avg:Min 0.4 VFC Avg, 4:1 Avg:Min	Medium Activity LZ2 1.0 HFC Avg, 2:1 Avg:Min 0.6 VFC Avg, 4:1 Avg:Min	Medium Activity LZ3 1.5 HFC Avg, 2:1 Avg:Min 0.8 VFC Avg, 4:1 Avg:Min	Medium Activity LZ4 2.0 HFC Avg, 2:1 Avg:Min 1.0 VFC Avg, 2:1 Avg:Min
Outdoor Dining	n/a	IES Handbook 10th Edition Table 22.2 "Food Service, Dinner Hospitality Properties" 2.0 HFC Avg, 3:1 Avg:Min 0.8 VFC Avg, 3:1 Avg:Min			
Special Security for Retail Parking and Pedestrian Hardscape	n/a	IES G-1-03 Table 1 "Supermarket, Major Retail Parking - Parking lot" 3.0 HFC Avg; 4:1 Avg:Min 0.5 VFC Avg, 4:1 Avg:Min			

Table 140.7-B Specific Applications

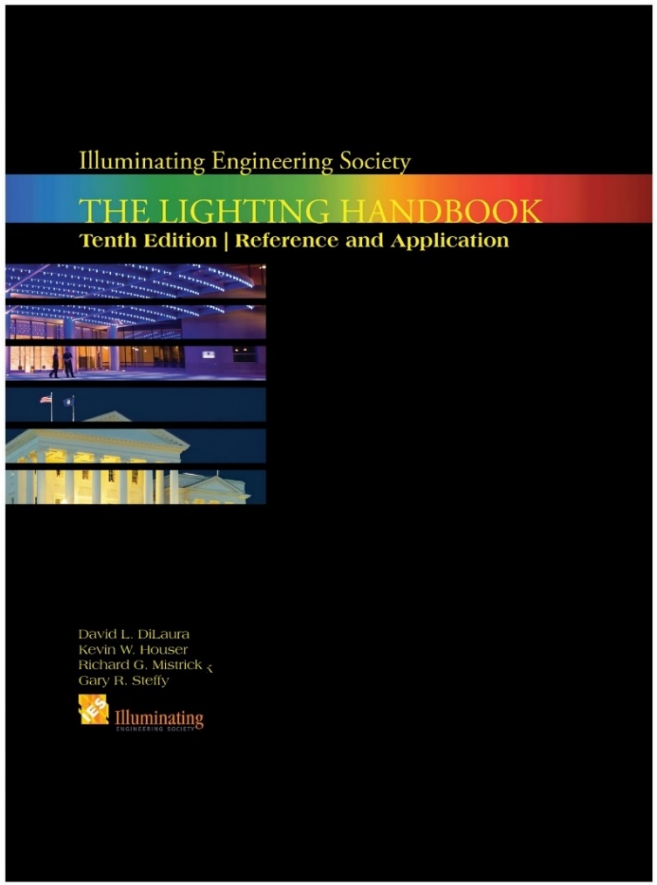
- LPAs in addition to general hardscape
  - Entrances
  - Drive-up windows
  - ATMs
  - Gas station (covered and uncovered pumps and hardscape)
  - Retail (auto) sales lots
  - Retail sales frontage
  - Building facades
  - Sales canopies
  - Non-sales canopies and tunnels

TABLE 140.7-B ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS
All area and distance measurements in plan view unless otherwise noted.

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.					
Building Entrances or Exits. Allowance per door. Luminaires must be within 20 feet of the door.	Not applicable	15 watts	25 watts	35 watts	45 watts
Primary Entrances to Senior Care Facilities, Police Stations, Hospitals, Fire Stations, and Emergency Vehicle Facilities. Allowance per primary entrance(s) only. Primary entrances are entrances that provide access for the general public. This allowance is in addition to the building entrance or exit allowance above. Luminaires must be within 100 feet of the primary entrance.	Not applicable	45 watts	80 watts	120 watts	130 watts
Drive Up Windows. Allowance per customer service location. Luminaires must be within 2 mounting heights of the sill of the window.	Not applicable	40 watts	75 watts	125 watts	200 watts
Vehicle Service Station Uncovered Fuel Dispenser. Allowance per fueling dispenser. Luminaires must be within 2 mounting heights of the dispenser.	Not applicable	120 watts	175 watts	185 watts	330 watts
ATM Machine Lighting. Allowance per ATM machine. Luminaires must 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.					
Outdoor Sales Frontage. 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 must be located between the principal viewing location and the frontage outdoor sales area.	Not applicable	No Allowance	22.5 W/linear ft	36 W/linear ft	45 W/linear ft
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used for any illuminated hardscape area on the site.					
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires must be rated for 100 watts or less and be post-top luminaires, lanterns, pendant luminaires, or chandeliers.	Not applicable	No Allowance	0.02 W/ft²	0.04 W/ft²	0.06 W/ft²
WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²). May be used as appropriate provided that only one is used for a given area (i.e., provided that two allowances are not applied to the same area).					
Building Facades. Only areas of building façade that are illuminated qualify for this allowance. Luminaires must be aimed at the façade and capable of illuminating it without obstruction or interference by permanent building features or other objects.	Not applicable	No Allowance	0.18 W/ft²	0.35 W/ft²	0.50 W/ft²
Outdoor Sales Lots. 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 are considered hardscape areas even if these areas are completely surrounded by sales lots on all sides. Luminaires must be within 5 mounting heights of the sales lot area.	Not applicable	0.164 W/ft²	0.555 W/ft²	0.758 W/ft²	1.285 W/ft²
Vehicle Service Station Hardscape. Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires must be illuminating the hardscape area and must not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	Not applicable	0.014 W/ft²	0.155 W/ft²	0.308 W/ft²	0.485 W/ft²
Vehicle Service Station Canopies. 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/ft²	1.005 W/ft²	1.300 W/ft²	2.200 W/ft²
Sales Canopies. Allowance for the total area within the drip line of the canopy. Luminaires must be located under the canopy.	Not applicable	No Allowance	0.655 W/ft²	0.908 W/ft²	1.135 W/ft²
Non-sales Canopies and Tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires must be located under the canopy or tunnel.	Not applicable	0.084 W/ft²	0.205 W/ft²	0.408 W/ft²	0.585 W/ft²

Current Code Requirements

- Hardscape LPA based on RP-20-14 and older generation of LED efficacy luminaires.
- 2016 Title 24 LPAs were based on legacy products
  - Pulse-start metal halide, induction, fluorescent, and CFL
- Based on IES recommendations
  - 10th Edition Handbook, TM-15-11, RP-8-14, RP-20-14, RP-33-14, and G-1-03



Current Code Requirements

- BUG Ratings per IESNA TM-15-11
- Hardscape lighting has shielding requirements in Section 130.2 (UG ratings)
- Backlight ratings in CALGreen

TABLE 130.2-A Uplight Ratings (Maximum Zonal Lumens)

	Maximum Zonal Lumens per Outdoor Lighting Zone			
Secondary Solid Angle	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Uplight High (UH) 100 to 180 degrees	10	50	500	1,000
Uplight Low (UL) 90 to <100 degrees	10	50	500	1,000

TABLE 130.2-B Glare Ratings (Maximum Zonal Lumens)

Glare Rating for Asymmetrical Luminaire Types (Type 1, Type II, Type III, Type IV)				
	Maximum Zonal Lumens per Outdoor Lighting Zone			
Secondary Solid Angle	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Forward Very High (FVH) 80 to 90 degrees	100	225	500	750
Backlight Very High (BVH) 80 to 90 degrees	100	225	500	750
Forward High (FH) 60 to <80 degrees	1,800	5,000	7,500	12,000
Backlight High (BH) 60 to <80 degrees	500	1,000	2,500	5,000
Glare Rating for Quadrilateral Symmetrical Luminaire Types (Type V, Type V Square)				
	Maximum Zonal Lumens per Outdoor Lighting Zone			
Secondary Solid Angle	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Forward Very High (FVH) 80 to 90 degrees	100	225	500	750
Backlight Very High (BVH) 80 to 90 degrees	100	225	500	750
Forward High (FH) 60 to <80 degrees	1,800	5,000	7,500	12,000
Backlight High (BH) 60 to <80 degrees	1,800	5,000	7,500	12,000

Typical Practices

- Current practices
  - A designer can meet IES criteria and meet the LPAs.
  - General outdoor lighting is tradable within spaces with some limitations, remaining allowance in one area can be “banked” for use in other areas.

Outdoor Lighting Trends

- Trends
  - LED technology is being used more because of lower cost, higher efficiencies, and higher quality equipment.
  - The LPA limits will become increasingly less restrictive if LPA values remain unchanged while new light sources improve (LED).
  - LEDs account for 90% of Outdoor Luminaires on West Coast

- By 2025 virtually all outdoor lighting sales will be LED[1]

1. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/energysavingsforecast14.pdf

Current Code Requirements

- Example LED lighting
  - LEDs can provide increased acuity, brightness, and even distribution
  - Lower LPAs does not mean less lighting quality

Incremental Cost Estimation

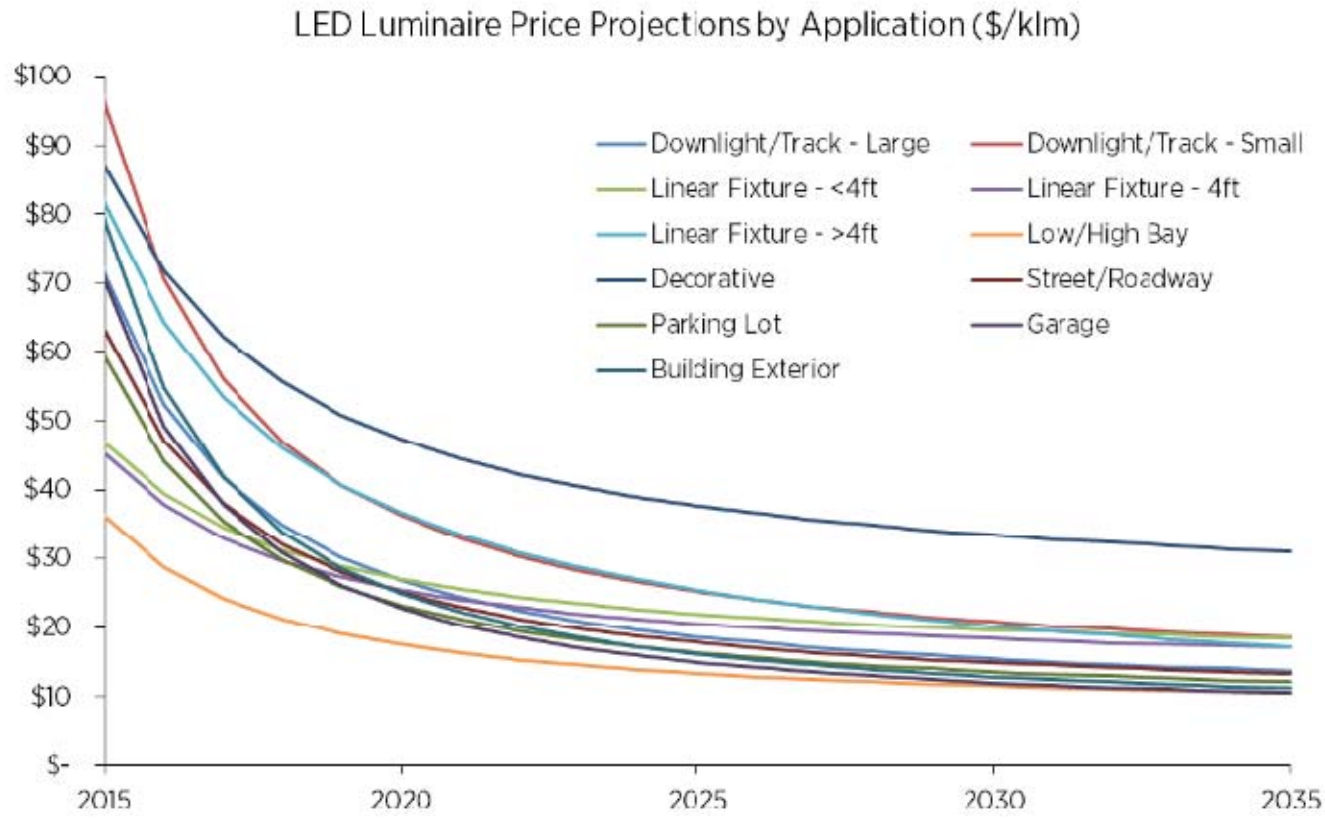
- Projected decrease in LED costs
  - DOE price projections show exterior luminaire price drop to 60-70% k/Lm by 2020

Application Submarkets	2015	2020
Area and Roadway	$63	$25
Parking Lot	$59	$23
Garage	$70	$23
Building Exterior	$79	$25

Source: http://www.energy.gov/sites/prod/files/2016/09/f33/energysavingsforecast16_2.pdf

Incremental Cost Estimation

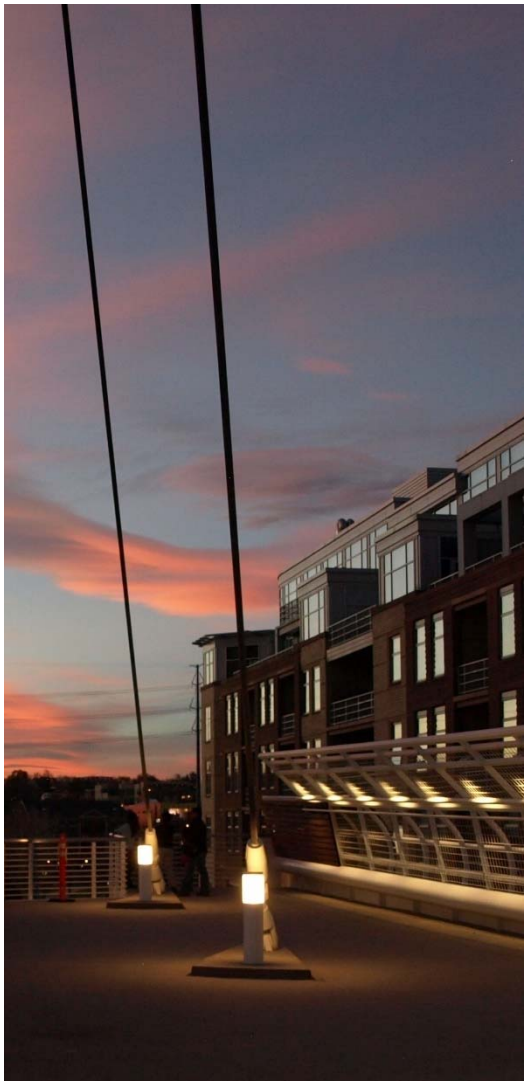
- Projected decrease in LED costs cont.
  - DOE price projections show exterior luminaire price drop to 60-70% k/Lm by 2020



Source: http://www.energy.gov/sites/prod/files/2016/09/f33/energysavingsforecast16_2.pdf

Market Overview and Analysis

- Current Market
  - LED market is well established
  - There are utility incentive programs for LED installations
  - People are voluntarily installing higher efficacy LEDs
    - Do you agree?
- Market impacts
  - Exterior lighting accounts for at least 8% of total commercial lighting energy use (24 TWh in 2009; approximately 2.9TWh for CA alone)[1]
    - LPAs are expected to drop as much as 50% for certain applications



1. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-20579.pdf

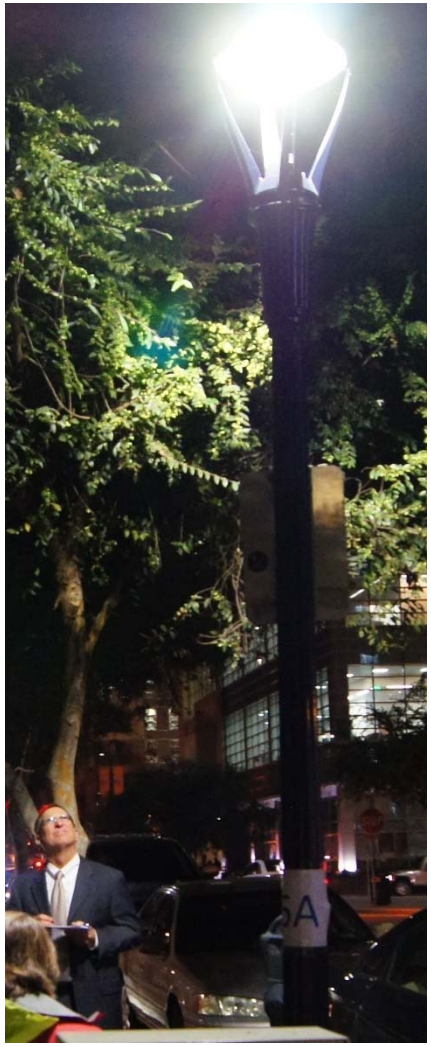
Market Overview and Analysis

- Market barriers
  - Cost of LED luminaires
  - Efficacy differences between LED color temperatures
  - Control system compatibility
  - Driver standards
- Benefits of LEDs
  - Long life (can last 30,000+ hours) means less maintenance costs[1]
  - Typically do not burn out or fail[2]
  - Potential to have higher energy efficiency than any other light source[1]
- Other market trends we should know about?
  - Will legacy products be phased out?
  - Are there issues with 3000K LED products (Cost, efficacy, availability, etc.)?
  - What is the preferred dimming control protocol?

1. http://energy.gov/eere/ssl/led-basics#how_long
2. https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_led_bulbs#led_different

Incremental Cost Estimation

- Basis of cost analysis
  - Product cost (C/N for San Francisco)
  - 2016 Time Dependent Valuation Methodology
  - Solid State Lighting Trend Analysis
  - Maintenance cost over 15 years
  - Control schedule (luminaire energy use)
- What components of costs did we leave out?
  - Driver replacement
  - Control system cost
  - Installation cost



Incremental Cost Estimation

- 15 year LED cost effectiveness is based on a Benefit/Cost ratio
- Based on maintained lumens
  - LED lumen outputs were compared to legacy products
- LED cost is expected to be less than legacy products by 2019

- Do you find these methods to be reasonable?
  - Please reach out individually to provide cost data

Methodology for Savings Analysis

- Methodology for LPA determination
  - Spreadsheet analysis
    - Control schedule
    - Product use per lighting zone
    - Maintained luminaire lumens
    - Legacy product lumen output compared to LED
  - Prototype Buildings
    - Nonresidential: 5,000 – 500,000 SF hardscape area
    - Use current IES guidelines

Control Schedules

	Schedule A	**Schedule B**	**Schedule C**
	Dusk to Dawn	Dusk to 10PM	Dusk to Midnight
On	Dusk - 30min	Dusk - 30min	Dusk - 30min
Off	Dawn + 30min	22:00	0:00
Partial Off	n/a	n/a	n/a
Annual Hours	**4,690**	**1,568**	**1,933**

Methodology for Savings Analysis

- Methodology for energy and demand impacts
  - Assumptions and proxies for estimating outdoor construction

Assumptions for Statewide Estimates - Specific Applications

Lighting Allowance	Assumptions	Applied to % of Building S.F. in Category								
		Office, I G & Std	Retail	Restaurant	Food (Grocery)	Warehouse, Ref & NR	Hotel	School	College	Other
Building Entrances or Exits	1 per 6000 sf of building interior (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	1 per 6000 SF of gross building area (1 primary entrance per building)									1%
Drive Up Windows	1 per 1800 SF of gross building area (2 locations per building; 1000 sf building)			30%						
Vehicle Service Station Uncovered Fuel Dispenser	1 per 100 sf of gross building area (1 fuel dispenser face per 25 sf of station building interior)									0.01%
Automated Teller Machines	400W MH luminaire as typical standard practice, switch to 250W limit for first location, 2500 sf per ATM installation.									1%
Outdoor Sales Frontage	0.2 LF per sf of gross building area (1 display parking space per 60 sf of building interior)									1.6%
Landscape Ornamental Lighting	0.1 SF per SF of gross building area	60%	60%	60%	26%		60%	26%	26%	6%
Building Facades	30' building height, 2 floors per building (20% of applicable facades are lit)	25%	60%	60%	25%		60%	26%	26%	6%
Outdoor Sales Lots	4 SF of sales lot per sf of gross building area (1 display parking space per 60 sf of building interior)									1.6%

Methodology for Savings Analysis

- Methodology for energy and demand impacts
  - Assumptions and proxies for estimating outdoor construction cont.

Assumptions for Statewide Estimates - Specific Applications

Lighting Allowance	Assumptions	Applied to % of Building S.F. in Category								
		Office, G & Sm	Retail	Restaurant	Food (Grocery)	Warehouse, Ref & NR	Hotel	School	College	Other
Vehicle Service Station Hardscape	11 SF per SF of gross building area									1%
Vehicle Service Station Canopies	1.2 SF of canopy per SF of gross building area									1%
Sales Canopies	0.1 SF of canopy per SF of gross building area									0%
Non-sales Canopies	0.1 SF of canopy per SF of gross building area	20%	20%	20%	20%		20%	20%	20%	0%
Guard Stations	0.00043 sf per SF of gross building area (1 12x18 guard station per 500,000 sf of total construction)	100%				100%			100%	100%
Student Pick-up/Drop-off zone	0.0173 sf per SF of gross building area (1 12x72 drop off per 60,000 sf of total construction)							100%		
Outdoor Dining	1 sf per 5 sf of gross building area (20% of typical building sf)		2.6%	60%	2.6%					
Special Security Lighting for Retail Parking and Pedestrian Hardscape	1 SF per 100 SF gross building SF (1% of hardscape)		100%	100%	100%					60%

Methodology for Savings Analysis

- Methodology for energy and demand impacts
  - Assumptions and proxies for estimating outdoor construction cont.

Assumptions for Statewide Estimates - General Hardscape

General Hardscape	Assumptions	Area Multipliers for Construction S.F.
for Large Office, Small Office, Food, Restaurant, College	1 parking space per 250 sf of gross building area	1
for Hotel, Retail, School, Other	1 parking space per 360 sf of gross building area	0.7
for NR Warehouse, Ref. Warehouse	1 parking space per 830 sf of gross building area	0.3

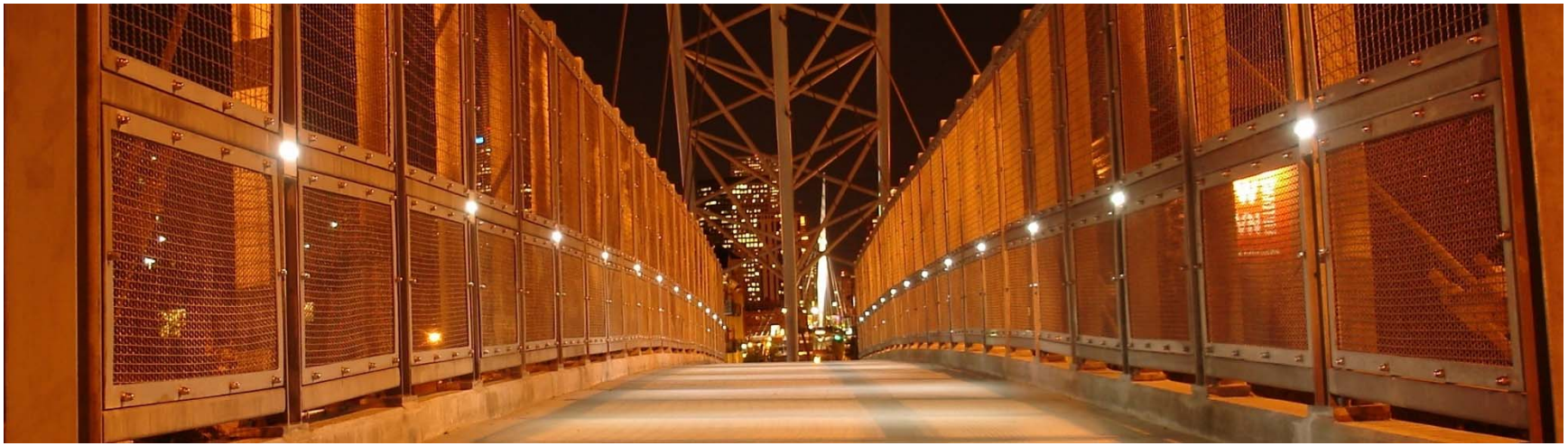
Methodology for Savings Analysis

- Methodology for energy and demand impacts
  - Assumptions and proxies for estimating outdoor construction cont.
  - Do you have any recommendations for our proxies and assumptions?

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%

Assumptions for Energy Impacts Analysis

- Key assumptions
  - Operating hours: 4,690 maximum with dusk-to-dawn operation (less with occupancy sensor and dimming schedules)
  - Fraction of buildings or building types containing targeted technology: All nonresidential buildings with exterior lighting



Assumptions for Energy Impacts Analysis

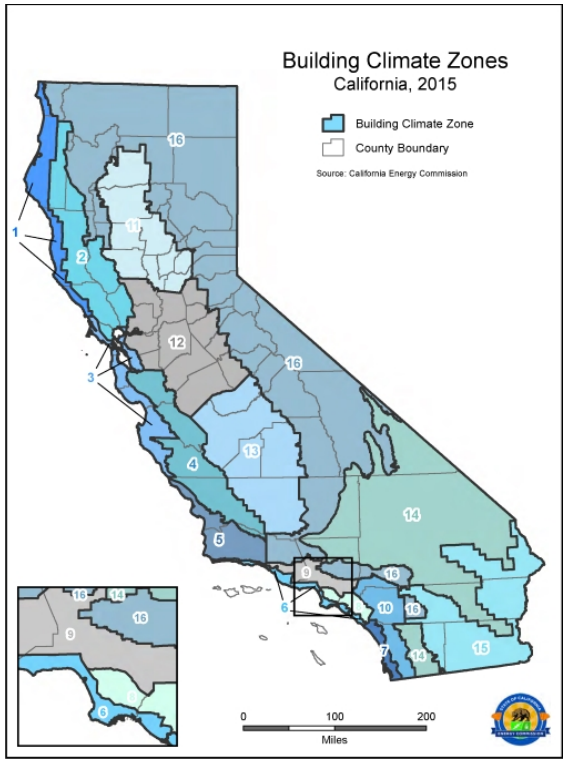
- Data sources
  - 2016 CASE Report Title “Nonresidential Outdoor Lighting Power Allowance”
  - Department of Energy, including the Building Technology Office (standards development materials), the CALiPER program, the Multi-year Program Plan, SSL Pricing and Efficacy Trend Analysis, and other DOE research initiatives and publications
  - California Energy Commission Time Dependent Valuation of Energy (TDV), ACM Manual
  - Navigant Consulting, Inc LED efficiency and savings
  - Pacific Northwest National Laboratory LED efficiency and savings
  - California Air Resources Board Cost effectiveness methodology
  - Online data

Assumptions for Energy Impacts Analysis

- Data sources (continued)
  - Literature on Blue Light at Night Issues:
    - Int J Mol Sci. 2014 Dec 17. Protecting the melatonin rhythm through circadian healthy light exposure.
    - American Medical Association “Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting”
    - Abraham Haim; The Israeli Center for Interdisciplinary Research in Chronobiology, University of Haifa; December 2014. Searching for the Link between Artificial Light at Night and Health
    - Lionel Shriver, New York Times October 2015; Ruining That Moody Urban Glow.
  - Product Performance Databases:
    - ENERGY STAR Luminaires Qualifying Products List
    - Lighting Facts Database
    - Design Lights Consortium Qualifying Product List
  - Manufacturer product reports
  - Data sources recommendations?

Incremental Cost Savings

- Approach
  - Incremental cost savings are calculated based on TDV cost savings associated with energy savings over the entire period of analysis.
  - Present TDV cost multiplier ($/TDV kBTU)
  - TDV per California's Building Climate Zones
  - Maintained lumen output comparison
  - Maintenance cost (material and labor cost over 15 years)
  - Using DOE projected product cost decreases
  - Using DOE projected efficacy increases
- Reasonable assumptions?



Compliance and Enforcement

- CASE Team will be interviewing stakeholders to identify potential barriers to code compliance and enforcement

- Will need to update existing compliance forms related to nonresidential outdoor lighting

Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
Lighting Designers	- Design lighting system to meet Title 24 code - System performs to owner specifications & needs. - Compliance forms	- System meets owner needs - Do this quickly and within budget and schedule - Do this cost-effectively - System is Title 24 compliant
Contractor/Builder	- Build system exactly as designed to meet code - Purchase system from retailers/distributors - Coordinate with other market actors - Work on-site	- Do this quickly and within budget and schedule - Do this with minimal paperwork - System is Title 24 compliant

Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
Electrician	- Install lighting system - Follow lighting design - Coordinate with contractor/builder	- System is Title 24 compliant - Install to meet owner specifications - System functions properly - On schedule and within budget
Energy Consultant/Modeler	- Generate compliance documentation and fill out paperwork - Provide assistance in code interpretation - Run compliance model if necessary	- Compliance documents are properly filled out and system is compliant - Avoid redesigning related code requirements - Minimal energy code related plan check comments - Do this virtually/ remote

Strawman Code Change Language

- Table 140.7-A General Hardscape
  - Add two new lines for concrete hardscape and asphalt hardscape
    - Remove footnote for concrete
  - Lower LPAs if cost effective and meets IES guidelines
- Table 140.7-B Specific Applications
  - Lower LPAs if cost effective and meets IES guidelines

Feedback Request from Stakeholders

- Other input?
- Please provide additional feedback and/or data to the CASE Team
  - Nancy Clanton
    - nancy@clantonassociates.com
    - (303)530-7229
  - Annie Kuczkowski
    - annie@clantonassociates.com
    - (303)530-7229
  - Mike McGaraghan
    - mmcgaraghan@energy-solution.com
    - (510)482-4420 ext.242
  - Chris Uraine
    - curaine@energy-solution.com
    - (510)482-4420 ext.243

Questions?

Appendices

Appendix: Other regulatory considerations

- Evolving Appliance Standards for Lighting:
  - Adopted Title 20 Standards in effect by 2020 (150W - 500W Metal Halide luminaires)
    - Already effective (2015)
    - Minimum ballast efficiencies of ≥88% (depending on compliance option)

Appendix: Other regulatory considerations

- Proposed Federal Standards in effect by 2020-2023
  - Metal Halide lamp ballasts and fixtures: 150W – 1,000W
    - Minimum ballast efficiencies of ≥88% (150W – 500W depending on ballast)
    - No probe-start ballast (500W – 1,000W effective 2017)
  - No energy conservation standards for HID lamps (high-pressure sodium, mercury vapor, and metal halide)