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General Service Lamps (Expanded Scope)

Response to the California Energy Commission's Invitation to
Participate Phase 2 Pre-Rulemaking
General Services Lamps (Expanded Scope)
17-AAER-07

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Prepared for:



Prepared by:

Phi Nguyen, Ph.D., ENERGY SOLUTIONS
Axel Pearson, ENERGY SOLUTIONS
Michael McGaraghan, ENERGY SOLUTIONS

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1. Executive Summary

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (Energy Commission) efforts to update California's Appliance Efficiency Regulations (Title 20) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), Southern California Edison (SCE), and SoCalGas® – sponsored this effort (herein referred to as the Statewide CASE Team). The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve the energy and water efficiency of various products sold in California. The information presented herein is a response to the Energy Commission's Invitation to Participate Phase 2 Pre-Rulemaking for general service lamps (GSL).

This response provides background information for GSL, as defined by the United States (U.S.) Department of Energy (DOE) in the General Service Lamp Final Rules published on January 19, 2017 (herein referred to as the 'DOE Final Rules'). The response also reviews potential changes in definition for various lamp types not defined as GSL, such that any excluded lamps are well-defined. Lastly, the response recommends general guidance for the methodology for estimating statewide energy savings and for determining cost-effectiveness. This response is being submitted to the Energy Commission in response to the Notice of Invitation to Participate docketed on April 21, 2017, and the Staff Webinar Regarding Phase II Pre-Rulemaking on May 11, 2017.

2. Background

2.1 Scope

The scope of this response is limited to lamps that are newly-defined as GSLs per the DOE Final Rules, and to lamps that are explicitly excluded from this definition. If the Energy Commission adopts the same GSL definition adopted by DOE, the newly-defined GSLs will be required to meet Title 20 GSL requirements, which will include a 45 lumen per watt efficacy requirement for lamps manufactured on or after January 1, 2018. Many of the lamps that are excluded from this definition have also been redefined by DOE to ensure that they may only be used for non-general service applications. Since these lamps are not federally covered products, the Energy Commission may choose to expand the scope of GSLs beyond the DOE Final Rules definition to include these lamps and capture additional savings. The Statewide CASE Team thus included these lamps within this background discussion for the Energy Commission’s consideration.

In general, the new definition for GSLs includes all lamps that can be used for general service applications of all ANSI base types, including general service incandescent lamps (GSIL), incandescent reflector lamps (IRL), general service LED lamps, and several lamps that were previously excluded from the definition of GSIL, per the Energy Independence and Security Act of 2007 (commonly referred to as the “EISA-Exempt Lamps”). This is considered an “expanded scope,” because the previous federal definition of GSL (before the DOE Final Rules) did not include IRLs, any EISA-Exempt Lamps, any lamps that do not have a medium base (E26), or lamps with light output greater than 2,600 lumens. The DOE Final Rules redefined GSLs as follows:

“General service lamp” means a lamp that has an ANSI base; is able to operate at a voltage of 12 volts or 24 volts, at or between 100 to 130 volts, at or between 220 to 240 volts, or of 277 volts for integrated lamps (as defined in this section), or is able to operate at any voltage for non-integrated lamps (as defined in this section); has an initial lumen output of greater than or equal to 310 lumens (or 232 lumens for modified spectrum general service incandescent lamps) and less than or equal to 3,300 lumens; is not a light fixture; is not an LED downlight retrofit kit; and is used in general lighting applications. General service lamps include, but are not limited to, general service incandescent lamps, compact fluorescent lamps, general service light-emitting diode lamps, and general service organic light-emitting diode lamps. General service lamps do not include:

- (1) *Appliance lamps;*
- (2) *Black light lamps;*
- (3) *Bug lamps;*
- (4) *Colored lamps;*
- (5) *G shape lamps with a diameter of 5 inches or more as defined in ANSI C79.1–2002 (incorporated by reference; see § 430.3);*
- (6) *General service fluorescent lamps;*
- (7) *High intensity discharge lamps;*
- (8) *Infrared lamps;*
- (9) *J, JC, JCD, JCS, JCV, JCX, JD, JS, and JT shape lamps that do not have Edison screw bases;*

- (10) *Lamps that have a wedge base or prefocus base;*
- (11) *Left-hand thread lamps;*
- (12) *Marine lamps;*
- (13) *Marine signal service lamps;*
- (14) *Mine service lamps;*
- (15) *MR shape lamps that have a first number symbol equal to 16 (diameter equal to 2 inches) as defined in ANSI C79.1–2002 (incorporated by reference; see § 430.3), operate at 12 volts, and have a lumen output greater than or equal to 800;*
- (16) *Other fluorescent lamps;*
- (17) *Plant light lamps;*
- (18) *R20 short lamps;*
- (19) *Reflector lamps (as defined in this section) that have a first number symbol less than 16 (diameter less than 2 inches) as defined in ANSI C79.1–2002 (incorporated by reference; see § 430.3) and that do not have E26/E24, E26d, E26/50x39, E26/53x39, E29/28, E29/53x39, E39, E39d, EP39, or EX39 bases;*
- (20) *S shape or G shape lamps that have a first number symbol less than or equal to 12.5 (diameter less than or equal to 1.5625 inches) as defined in ANSI C79.1–2002 (incorporated by reference; see § 430.3);*
- (21) *Sign service lamps;*
- (22) *Silver bowl lamps;*
- (23) *Showcase lamps;*
- (24) *Specialty MR lamps;*
- (25) *T shape lamps that have a first number symbol less than or equal to 8 (diameter less than or equal to 1 inch) as defined in ANSI C79.1–2002 (incorporated by reference; see § 430.3), nominal overall length less than 12 inches, and that are not compact fluorescent lamps (as defined in this section);*
- (26) *Traffic signal lamps;*

Specifically, when compared to the previous federal definition of GSLs, this new definition now covers the following lamps of all base types: reflector lamps greater than two inches in diameter; rough service lamps; shatter-resistant lamps; three-way incandescent lamps; vibration lamp; T-shape lamps (as defined in ANSI C78.20-2003 and C79.1-2002) that use not more than 40 watts or have lengths of more than 10 inches; A B, BA, CA, F, G16 1/2, G-25, G30, S, or M-14 lamp (as defined in ANSI C79.1-2002 and ANSI C78.20-2003) of 40 watts or less; GSIL lamps with light output of greater than 2,600 lumens, but less than or equal to 3,300 lumens; and incandescent reflector lamps.

2.2 Regulatory Background

2.2.1 Federal Regulatory Background

The Energy Independence and Security Act (EISA) of 2007 established minimum energy efficiency standards for GSILs, based on rated wattage, which included statutory exemptions for twenty-two lamp types (“EISA-exempt lamps”). EISA also defined in 42 USC §6925, the GSL lamp as a broad classification for all lamps that can serve as general service lighting including GSILs, and provided provisions for updating energy conservation standards for GSLs through a rulemaking process. Within this rulemaking, DOE may also determine whether previous lamp exemptions, including the EISA-exempt lamps, are warranted based in part on whether the lamps may be used for general service applications.

In addition, EISA also directed DOE to establish a benchmark unit sales estimate for five “other” lamp types – rough service lamps, vibration service lamps, 3-way incandescent lamps, 2,601-3,300 lumen general service incandescent lamps, and shatter-resistant lamps – by collecting, analyzing, and monitoring unit sales for these lamp types, as provided by the National Electrical Manufacturers Association (NEMA). If in any year, any of these lamps surpass a predetermined sales threshold, EISA directs DOE to establish energy conservation standards for that lamp type through an “accelerated rulemaking” process.

DOE released a Preliminary Technical Support Document (PTSD) on December 11, 2014, to update federal energy conservation standards for GSLs [DOE 2014]. However, a “rider” in the House Energy and Water appropriation bill, herein referred to as the “Burgess Rider”, would prohibit DOE from using funds to implement or enforce standards for GSILs. On March 17, 2016, DOE released a Notice of Proposed Rulemaking (NOPR) that proposed standards for the GSLs that are not blocked by the Burgess Rider, i.e., non-GSILs [DOE 2016a].

On April 7, 2016, DOE released a Notice of Data Available announcing that sales for vibration service lamps have surpassed the predetermined threshold, but gave no clear indication of how DOE intended to initiate an accelerated rulemaking [DOE 2016b]. On September 20, 2016, DOE published a memorandum memorializing a discussion between DOE and NEMA, where NEMA representatives identified an error that miscalculated the sales of rough service lamps, and that rough service lamps had also surpassed their respective sales threshold [DOE 2016c].

On October 18, 2016, DOE released a Notice of Proposed Determination and Data Availability (NOPDDA), which proposed to redefine GSLs under the provisions to assess which exemptions should continue [DOE 2016d]. DOE determined that the Burgess Rider applies only to energy conservation standards, and that DOE must fulfil its obligations of determining whether GSL exemptions, including the EISA-exempt lamps, should continue. In addition, DOE considered this NOPDDA to be the “accelerated rulemakings” that must be initiated for vibration service and rough service lamps. After consideration of comments, DOE released two Final Rules (the ‘DOE Final Rules’) on January 19, 2017, that finalized definition changes for GSLs and excluded lamps, effectively expanding the scope of GSLs to the lamp types covered in this response.

2.2.2 California Regulatory Background

California Title 20 Appliance Efficiency Regulations have long regulated GSILs and IRLs. Currently, Title 20 GSIL and IRL standards mirror federal requirements due to the federal preemption provisions in 42 USC §6927. These requirements are shown in Table 2.1 and Table 2.2 for GSILs and IRLs, respectively.

Table 2.1. Standards for Federally-Regulated General Service Incandescent Lamps

Rated Lumen Ranges	Maximum Rate Wattage	Minimum Rate Lifetime	Effective Date
1,490 – 2,600	72	1,000 hours	January 1, 2012
1,050 – 1,489	53	1,000 hours	January 1, 2013
750 – 1,049	43	1,000 hours	January 1, 2014
310 - 749	29	1,000 hours	January 1, 2014

Table 2.2. Standards for Federally-Regulated Incandescent Reflector Lamps Manufactured on or After July 15, 2012

Lamp Spectrum	Lamp Diameter (inches)	Rated Voltage	Minimum Average Lamp Efficacy (LPW)*
Standard Spectrum	> 2.5	≥ 125	$6.8 \times P^{0.27}$
	> 2.5	< 125	$5.9 \times P^{0.27}$
	≤ 2.5	≥ 125	$5.7 \times P^{0.27}$
	≤ 2.5	< 125	$5.0 \times P^{0.27}$
Modified Spectrum	> 2.5	≥ 125	$5.8 \times P^{0.27}$
	> 2.5	< 125	$5.0 \times P^{0.27}$
	≤ 2.5	≥ 125	$4.9 \times P^{0.27}$
	≤ 2.5	< 125	$4.2 \times P^{0.27}$

* P = Rated Lamp Wattage, in watts

Although GSILs are also federally-covered products, a “carveout” in EISA allows California to adopt a 45 lumen per watt (lm/W) “backstop” requirement, or any other DOE Final Rule, effective beginning on or after January 1, 2018. Per 42 USC §6295, the provision reads as follows:

(vi) State preemption – Neither section 6297(b) of this title nor any other provision of law shall preclude California or Nevada from adopting, effective beginning on or after January 1, 2018—

I. a final rule adopted by the Secretary in accordance with clauses (i) through (iv);

- II. *if a final rule described in subclause (I) has not been adopted, the backstop requirement under clause (v); or*
- III. *in the case of California, if a final rule described in subclause (I) has not been adopted, any California regulations relating to these covered products adopted pursuant to State statute in effect as of December 19, 2007.*

Thus, California adopted the 45 lm/W requirement for GSLs, as shown in Table 2.3, with an effective date of January 1, 2018. In addition, the Energy Commission announced in a Title 20 Phase II Pre-Rulemaking notice released on April 21, 2017 their intention to consider adoption of the DOE Final Rules that redefined GSLs, thus expanding its scope to cover additional lamps, such as IRLs and several EISA-exempt lamps [CEC 2016]. This response provides background information in support of the Energy Commission’s proposal.

Table 2.3. Standards for Federally-Regulated General Service Lamps – Tier II

Lumen Ranges	Minimum Lamp Efficacy	Minimum Rated Lifetime	Effective Date
All	45 Lumens per Watt	1,000 Hours	January 1, 2018

2.3 Utility and Other Incentive Programs

The GSL product category is a focal point of IOU energy efficiency program strategies – promotional and incentive programs in support of high efficiency GSL replacement lamps (i.e., compact fluorescent lamps) have been implemented by the IOUs for many years. The IOUs are also currently running programs in support of light emitting diode (LED) GSLs. Several of these incentive programs, which include instant rebates from participating distributors, business efficient lighting rebates, and new construction incentives are listed here:

- <https://www.sdge.com/save-money/bright-ideas-savings>
- <https://www.sdge.com/2017-energy-efficiency-rebate-program>
- https://www.pge.com/en_US/business/save-energy-money/business-solutions-and-rebates/lighting/lighting.page
- <https://www.sce.com/wps/portal/home/business/savings-incentives/express-solutions>
- <http://www.ledaccelerator.com/>

For example, the PG&E 2016 LED Replacement Lamp Incentive Program provided distributors with up to \$18 per lamp for ENERGY STAR® LED replacement lamp sales to PG&E commercial customers, including PAR, MR, R/BR, A, candelabra, and globe shape lamps (PG&E 2016). Lodi Electric Utility offers rebates for ENERGY STAR certified LED lamps, Lompoc City Electric offers rebates for LED replacement lamps, and Pacific Power offers instant discount pricing on ENERGY STAR certified LED lamps at participating retailers (Lodi Electric Utility 2015, Lompoc City Electric 2016, Pacific Power 2016).

- Various utilities outside California including those bulleted below offer instant discounts in ENERGY STAR certified CFL and LED lamps: Arizona Public Service (APS) offers customers instant discounts on CFLs and LEDs at participating stores, including spiral and specialty CFLs.¹
- Ameren Illinois and Ameren Missouri offer instant discounts on CFLs and LEDs at participating stores.² For commercial customers, cash incentives are evaluable for replacing lamps with lamps that reduce wattage (incentive paid per W reduced).³
- Baltimore Gas and Electric Company (BGE) sponsors mark-downs on select ENERGY STAR certified LED bulbs.⁴
- Blooming Prairie Public Utilities offers rebates on ENERGY STAR certified LED lamps⁵
- CenterPoint Energy offers instant rebates on LEDs at participating stores.⁶
- Clallam County PUD offers instant rebates on CFLs at participating stores.⁷
- Clark Public Utilities provides instant rebates at participating stores on ENERGY STAR qualified LEDs and CFLs through the Simple Steps, Smart Savings program.⁸
- ComEd offers instant discounts at participating stores for ENERGY STAR certified standard and specialty LED lamps.⁹
- Consumer Power Inc. (CPI) offers discounts on select LED lamps, including several PAR, BR, and G-shaped lamps¹⁰
- DC Sustainable Energy Utility (DCSEU) is offering instant discounts on CFLs and LEDs at participating retailers¹¹
- Dayton Power & Light Company (DP&L) offers instant discounts on CFL and LED lamps at participating retailers¹²
- Delmarva Power is sponsoring discounts on select ENERGY STAR LED lamps at participating retailers¹³
- Duke Energy provides discounted CFL and LED lamps through an online Savings Store to Duke Energy customers¹⁴

¹ <https://www.aps.com/en/residential/savemoneyandenergy/lighting/Pages/home.aspx?src=lighting>

² <http://www.actonenergy.com/for-my-home/explore-incentives/energy-efficient-lighting>.

³ <http://www.actonenergy.com/for-my-business/explore-incentives/lighting-incentives>

⁴ <http://www.bgesmartenergy.com/residential/lighting-discounts>

⁵ <http://www.saveenergyinmycommunity.com/>

⁶ <http://www.centerpointenergy.com/en-us/residential/save-energy-money/electric-efficiency-programs/advanced-lighting-program>

⁷ <https://www.clallampud.net/conservation/>

⁸ <http://www.simplestepsnw.com/consumer/utility-offers/clark>

⁹ <https://www.comed.com/home-savings/discounts/Pages/default.aspx>

¹⁰ <http://www.cpi.coop/products/led-bulbs/>

¹¹ <https://www.dcseu.com/for-my-home/lighting/energy-efficient-lighting>

¹² <http://www.dpandl.com/save-money/residential/lighting-discounts-for-your-home/>

¹³ <http://homeenergysavings.delmarva.com/lighting-program>

¹⁴ <http://www.duke-energy.com/residential-savings-store>

- East Grand Forks Water and Light offers rebates on all ENERGY STAR CFLs and LEDs¹⁵
- Efficiency Maine offers discounted LED lamps and promotes ENERGY STAR products¹⁶

2.4 Model Codes and Voluntary Standards

The ENERGY STAR® Lamps Specification Version 2.0 includes omnidirectional lamps (A, BT, P, PS, S, and T shape), decorative lamps (B, BA, C, CA, DC, F, and G shape), and directional lamps (R, BR, ER, MR, MRX, and PAR shape) in addition to self-ballasted compact fluorescent lamps intended to replace ANSI standard incandescent lamps that do not meet Lamp Shape Dimension requirements (EPA 2014). Inclusion of these lamp types in the Specification addresses several EISA-exempt lamps including reflector lamps; G shape lamps with a diameter of 5 inches or more; T shape lamps that use less than 40 watts and have a length greater than 10 inches; and A, B, BA, CA, F, G16-1/2, G-25, G30, or S lamps of 40 watts or less.

Leadership in Energy and Environmental Design (LEED) credits for lighting quality can be achieved in the LEED Version 4 Building Design and Construction, Interior Design and Construction, and Operations and Maintenance hospitality rating systems if four of eight potential strategies are used, including 1) where all light sources have a Color Rendering Index (CRI) of 80 or higher (except fixtures intended to provide colored lighting, site lighting, or other special uses) and 2) for at least 75 percent of total connected lighting load, light sources have a rated life of at least 24,000 hours (at three-hour per start, if applicable).

¹⁵ <http://www.egf.mn/index.aspx?NID=262>

¹⁶ <http://www.energymaine.com/at-home/retail-lighting-program/>

3. Product Descriptions

3.1 Products Covered by Proposed Scope Expansion

3.1.1 Reflector Lamps



Figure 3.1. LED reflector lamps (PAR30, left, and BR30, right)

Sources: Image on left: 1000 Bulbs. <https://www.1000bulbs.com/product/100011/TCP-10BR3027K.html> ; Image on right: 1000 Bulbs. <https://www.1000bulbs.com/product/99879/TCP-14P30D30KFL.html>

Reflector lamps include the IRL product class, which currently have their own federal energy conservation standards, as shown in Table 2.2. DOE determined in the NOPDDA that these lamps can be used for general service applications. Moreover, DOE determined that EISA grants them authority to discontinue the exemption status of reflector lamps, effectively including IRLs within the GSL definition [DOE 2017].

LEDs are well suited to replace reflector lamps due to their directional nature, high efficacy, large range of lumen outputs, correlated color temperatures (CCT), shapes, and sizes. Between January and September 2016, the Statewide CASE Team identified LED large diameter (greater than 2.25 inches) directional LED lamps available from 46 different manufacturers on eight major retail websites (e.g., HomeDepot.com, Lowes.com, 1000bulbs.com, etc.), including 1,493 products with the following performance metrics in Table 3.1. In addition to the performance metrics listed above, there are also directional LED lamps with beam angles as low as 8,¹⁷ 9,¹⁸ and 10¹⁹ degrees, as well as CRI values of 95.³

¹⁷ <https://www.1000bulbs.com/product/117014/LED-01475.html>

¹⁸ <https://www.1000bulbs.com/product/114121/LED-00763.html>

¹⁹ <https://www.1000bulbs.com/product/117812/LED-01599.html>

Table 3.1. Summary of Directional Lamps Available from Eight Major Online Retailers

LED Shape	Number of Products	Average Efficacy (lm/W)	Min Lumens	Max Lumens	Min CCT	Max CCT
BR20	24	69.6	450	600	2,000	5,000
BR30	237	70.5	525	1,245	2,400	6,500
BR40	111	72.8	550	2,170	2,400	6,500
PAR20	164	64.2	200	1,200	2,400	6,500
PAR30	537	64.3	320	1,300	2,700	6,500
PAR38	370	69.1	620	2,400	2,400	6,000
R30	15	67.1	650	1,100	2,700	5,000
R40	35	69.7	800	2,550	2,700	6,500

The IOU incentive programs reported in Section 2.3 further demonstrate the availability of these products and the feasibility of the proposal in DOE’s NOPDDA. One example is in PG&E’s LED Accelerator Program (LEDA), where over 13,000 directional LED lamps have been installed since 2013 in major retail stores in California, such as Gap, Whole Foods, Banana Republic, Eddie Bauer, and more. Such installations show these products are cost effective and can provide high quality light required in retail settings.

3.1.2 Rough Service Lamps



Figure 3.2. A rough service lamp (incandescent)

Source: Ace Hardware. <http://www.acehardware.com/product/index.jsp?productId=3808053>

Since rough service lamps are defined by filament configuration, they are inherently incandescent lamps. Specifically, they are designed and marketed for “rough service” applications. A rough service lamp is defined in Title 20 as follows:

“Rough service lamp” means a lamp that:

- (1) has a minimum of 5 supports with filament configurations that are C-7A, C-11, C-17, and C-22 as listed in Figure 6-12 of the 9th edition of the IES Lighting Handbook, or similar configurations where lead wires are not counted as supports; and
- (2) is designated and marketed specifically for 'rough service' applications, with:
 - i. the designation appearing on the lamp packaging; and
 - ii. marketing materials that identify the lamp as being for rough service.

Rough service lamps are commonly available at less than 10 lm/W.²⁰ These lamps may be replaced by LED lamps, since LEDs are inherently more durable due to their solid-state electronics composition. The DOE Final Rules acknowledged that rough service lamps do not serve any unique utility that cannot be served by standard LED lamps, and that these lamps are likely being purchased as replacement GSILs (i.e., for use in general service applications) despite being marked and labeled for “rough service” applications.

Rough service lamps are one of five lamps that DOE monitors, as directed by EISA, using sales provided annually by NEMA. DOE is mandated to initiate an “accelerated rulemaking” should these lamps surpass a predetermined sales threshold, indicative of whether the lamp is being used as a GSIL replacement. DOE found that in 2015, rough service lamps surpassed this threshold [DOE 2016c]. DOE considers the GSL Final Rules to be the “accelerated rulemaking” required to regulate rough service lamps. These lamps are thus included in the new DOE Final Rules definition of GSL.

3.1.3 Shatter-Resistant Lamps



Figure 3.3. A shatter-resistant lamp (incandescent)

Source: Ace Hardware. <http://www.acehardware.com/product/index.jsp?productId=1287880>

²⁰ Philips Rough Service 75W Lamp at Home Depot (9.5 lm/W): <http://www.homedepot.com/p/Philips-75-Watt-Incandescent-A19-120-130-Volt-Rough-Service-Frosted-Light-Bulb-12-Pack-293605-0/204148590>;
SunLite Rough Service 60W Lamp at Wal-Mart (9.7 lm/W): http://www.walmart.com/ip/2-Pk-SUNLITE-60w-120v-A-Shape-Rough-Service-Clear-light-bulb/46434702?reviews_limit=10&

Shatter-resistant lamps are defined by their ability to contain the glass envelope of a lamp should it rupture. They are thus pertinent to only lighting technologies that employ glass casings. Specifically, they are designed and marketed as being shatter-resistant, shatter proof, or shatter-protected. A shatter-resistant lamp is defined in Title 20 as follows:

“Shatter-resistant lamp, shatter-proof lamp, or shatter-protected lamp” means a lamp that:

- (1) has a coating or equivalent technology that is compliant with the NSF/ANSI 51 and is designed to contain the glass if the glass envelope of the lamp is broken; and*
- (2) is designated and marketed for the intended application, with:*
 - a. the designation on the lamp packaging; and*
 - b. marketing material that identify the lamp as being shatter-resistant, shatter-proof, or shatter-protected.*

Shatter-resistant incandescent lamps are typically less efficacious than other incandescent lamps due to the outer coating surrounding the glass envelope. These lamps may be replaced by LED lamps, since most LEDs are enclosed by envelopes that do not shatter. The DOE Final Rules acknowledged that shatter-resistant lamps do not serve any unique utility that cannot be served by standard LED lamps, and that these lamps are likely being purchased as replacement GSILs.

Shatter-resistant lamps are another one of five lamps that DOE monitors, as directed by EISA, using sales provided annually by NEMA. While sales for shatter-resistant lamps have not surpassed the predetermined sales threshold, DOE concluded that shatter-resistant lamps will likely fill the market currently occupied by rough service and vibration service lamps. Therefore, shatter-resistant lamps are included in the new DOE Final Rules definition of GSL.

3.1.4 Three-way Lamps



Figure 3.4. An LED three-way lamp (incandescent)

Source: Cree. <http://creebulb.com/30-60-100-watt-replacement>

Three-way lamps are defined as lamps that utilize two filaments to provide three distinct levels of brightness. These lamps thus require a distinct type of luminaire capable of controlling both filaments separately. A three-way lamp is defined by Title 20 as follows:

“Three-way lamp” includes an incandescent lamp that employs two filaments, operated separately and in combination, to provide three light levels. The designation shall be on the lamp packaging, and marketing materials shall identify the lamp as being a three-way lamp.

The Title 20 definition of three-way lamps defined them as inherently incandescent. However, manufacturers also produce three-way compact fluorescent lamps (CFL) as a more efficient option.²¹ Additionally, while dimmable LED lamps are widely available, three-way LED lamps are also available (Figure 3.4) for consumers who wish to continue using their three-way luminaire while replacing their incandescent three-way lamps.

DOE conducted testing of an LED three-way lamp and found it had an efficacy of 111.4 lm/W at its middle setting. In addition, highly efficacious LED three-way lamps were already widely available from multiple manufacturers in 2016, including Philips (89 lm/W, middle setting), Cree (103 lm/W, middle setting), Westinghouse (90 lm/W, middle setting), and others. These lamps provide the same functionality as their incandescent counterparts; they can provide light at three distinct light levels.

3.1.5 Vibration Service Lamps

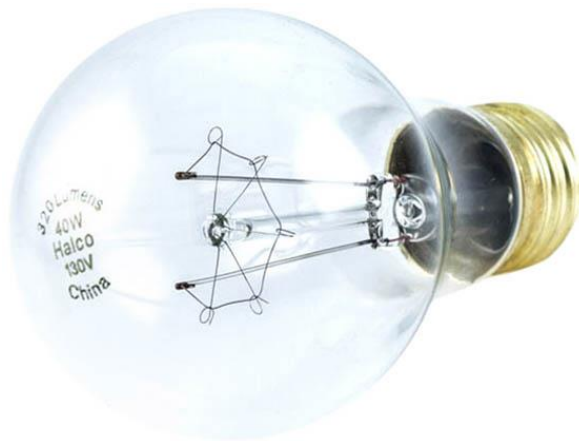


Figure 3.5. A vibration service lamp (incandescent)

Source: Bulbs.com. <http://www.bulbs.com/product/A19CL40-VS>

Like rough service lamps, vibration service lamps are defined by filament configuration, and are thus inherently incandescent lamps. Specifically, they are designed and marketed for “vibration-resistant” applications. A vibration service lamp is defined in Title 20 as follows:

“Vibration service lamp” means a lamp that:

²¹ https://www.lightbulbs.com/product/sylvania-29913/?source=GooglePPC-ProductAds&gclid=CjwKEAjwsLTJBRCvibaW9bGLtUESJAC4wKw1IPgTke9lsHIY0WOkLIYMvDFhPbSpCF1FLHoTZmq2nxoCTjXw_wcB

- (1) *has filament configurations that are C-5, C-7A, or C-9, as listed in Figure 6-12 of the 9th Edition of the IES Lighting Handbook or similar configurations;*
- (2) *has a maximum wattage of 60 watts;*
- (3) *is sold at retail in packages of two lamps or less; and*
- (4) *is designated and marketed specifically for vibration service or vibration-resistant applications with:*
 - a. *the designation appearing on the lamp packaging; and*
 - b. *marketing materials that identify the lamp as being vibration service only.*

Through review of retailer websites, the Statewide CASE Team found that many retailers do not make clear distinctions between rough service or vibration service.²² They are sometimes advertised for use as a garage light or ceiling fan light. These lamps may be replaced by LED lamps, since LEDs are inherently more vibration-resistant due to their solid-state electronics composition. The DOE Final Rules acknowledged that vibration service lamps do not serve any unique utility that cannot be served by standard LED lamps, and that these lamps are likely being purchased as replacement GSILs despite being marked and labeled for “vibration-service” applications.

Vibration service lamps are one of five lamps that DOE monitors, as directed by EISA, using sales provided annually by NEMA. Like sales of rough service lamps, DOE found that in 2015, vibration service lamps surpassed their predetermined sales threshold. DOE considers the GSL Final Rules to be the “accelerated rulemaking” required to regulate vibration service lamps. These lamps are thus included in the new DOE Final Rules definition of GSL.

²² Top Bulb. <http://www.topbulb.com/light-bulbs/rough-service>

4. Non-GSLs Potentially Covered in Separate Rulemaking

The products below are explicitly excluded from the definition of GSL from the DOE Final Rule, because they were determined not to be useful in general service applications. However, DOE revised the definitions of these lamp types (e.g., specified specific requirements) to minimize the potential for them becoming loophole products. When adopting the new definition for GSLs, the Energy Commission should also adopt the new definitions for these excluded lamps. Additionally, the Energy Commission may choose to consider these lamps in a separate rulemaking process. Since these lamps are not federally covered products, the Energy Commission is not restricted from regulating these.

In this section, the Statewide CASE Team provides some background and reviews the current Title 20 and new DOE Final Rules definitions for each type. Each of the lamp types presented below is also available as LED technology. Therefore, energy conservation standards that cover these lamp types would likely lead to cost-effective energy savings. Examples of the LED version of each lamp type are shown in the figures of each section below.

4.1.1 Black Light Lamps



Figure 4.1. An LED black light lamp

Source: Ace Hardware. <http://www.acehardware.com/product/index.jsp?productId=107173376>

Black light lamps are used for a variety of specialty applications, but do not produce light in the visible spectrum. These lamps can be incandescent, fluorescent, or LED, each utilizing different technologies to produce ultraviolet (UV) light. Of these technologies, incandescent black lights require the most power to operate (60 watts)²³ when compared to other efficiencies, and are also perhaps the least efficient of all incandescent lamps of any type, since they utilize UV filters that remove nearly all the light produced by incandescence.

Title 20 defines these lamps as follows:

²³ www.target.com/p/ge-60-watt-incandescent-party-light-bulb-black/-/A-13820943

“Black light lamp” means a lamp that emits radiant energy in the UV-A band (315-400 nm) and is designated and marketed as a “black light”. The designation shall be on the lamp packaging, and marketing materials shall identify the lamp as a black light lamp.

Conversely, the DOE Final Rule definition is slightly narrower, because it requires the lamp to have the “highest radiant power peaks” in the UV-A band, rather than simply being able to emit light at that wavelength. The DOE Final Rule definition that the Energy Commission should adopt is as follows:

“Black light lamp” means a lamp that is designed and marketed as a black light lamp and is an ultraviolet lamp with the highest radiant power peaks in the UV– A band (315 to 400 nm) of the electromagnetic spectrum.

4.1.2 Bug Lamps



Figure 4.2. An LED bug light

Source: Ace Hardware. <http://www.acehardware.com/product/index.jsp?productId=118982676>

Bug lamps are designed to emit yellow light, which is believed to repel certain types of insects. Functionally, these lamps are no different than yellow-colored lamps. For incandescent bug lamps, a color filter is required to produce the yellow light, while LED lamps may produce yellow light more efficiently by simply combining red and green LEDs.

Title 20 defines these lamps as follows:

“Bug Lamp” means a lamp that contains a filter to suppress the blue and green portions of the visible spectrum and is designated and marketed as a “bug light”. The designation shall be on the lamp packaging, and marketing materials shall identify the lamp as being a bug lamp.

The DOE Final Rule definition specifically requires the lamp to have the radiant power peaks above 550 nm, which is a slightly narrower definition than that of Title 20. The DOE Final Rule definition that the Energy Commission should adopt is as follows:

“Bug lamp” means a lamp that is designed and marketed as a bug lamp, has radiant power peaks above 550 nm on the electromagnetic spectrum, and has a visible yellow coating.

4.1.3 Colored Lamps



Figure 4.3. LED colored lamps (A19, MR16, PAR38, S14)

Source: 1000 Bulbs. <https://www.1000bulbs.com/category/led-colored-lamps>

Colored lamps are primarily designed for decorative purposes. Historically, these lamps were incandescent and utilized light filters to produce a desired color. Conversely, LED color lights can produce color without the use of filters, thus producing colored light more efficiently. Through web reviews, the Statewide CASE Team determined that colored lamps are widely available in many shapes and sizes, as shown in Figure 4.3.

Title 20 defines colored lamps for incandescent and fluorescent lamps separately:

“Colored incandescent lamp” means an incandescent lamp designated and marketed as a colored lamp that has:

- (1) a CRI of less than 50, as determined according to the test method given in CIE publication 13.3-1995; or*
- (2) a correlated color temperature less than 2,500K, or greater than 4,600K, where correlated color temperature is computed according to the Journal of Optical Society of America, Vol. 58, pages 1528-1595 (1968).*

“Colored fluorescent lamp” means a fluorescent lamp designated and marketed as a colored lamp, and not designed or marketed for general illumination applications with either of the following characteristics:

- (1) a CRI less than 40, as determined according to the method given in CIE publication 13.3-1995; or*
- (2) a correlated color temperature less than 2,500K or greater than 7,000K as determined according to the method set forth in IES LM-9-09.*

The DOE Final Rules consolidate the definition for colored lamps into a technology-independent class, which takes the more-stringent requirements for CRI and correlated color temperature. Additionally, the DOE Final Rules definition requires that these characteristics be maintained throughout all modes of operation, so that lamps that may modulate color, e.g., Smart LEDs, may not be exempt from standards. The DOE Final Rules definition is as follows:

Colored lamp means a colored fluorescent lamp, a colored incandescent lamp, or a lamp designed and marketed as a colored lamp with either of the following characteristics (if multiple modes of operation are possible [such as variable CCT], either of the below characteristics must be maintained throughout all modes of operation):

- (1) A CRI less than 40, as determined according to the method set forth in CIE Publication 13.3 (incorporated by reference; see § 430.3); or
- (2) A CCT less than 2,500 K or greater than 7,000 K.

4.1.4 Infrared Lamps



Figure 4.4. An LED infrared lamp (parabolic)

Source: 1000 Bulbs. <https://www.1000bulbs.com/product/5661/SATCO-S4998.html>

Infrared (IR) lamps are primarily used as heat lamps, or for medical applications. Like black light lamps, the incandescent versions of these lamps utilize IR filters to produce light that is of the appropriate wavelength. As with black light, bug, or color lamps, LEDs may directly produce IR light, thus producing the desired wavelengths more efficiently. The Statewide CASE Team found LED IR lamps to be widely available, as shown in Figure 4.4.

Title 20 defines these lamps as follows:

“Infrared lamp” means a lamp that radiates predominately in the infrared region of the electromagnetic spectrum, and where visible radiation is not of principal interest. The designation shall be on the lamp packaging, and marketing materials shall identify the lamp as being an infrared lamp.

Conversely, the DOE Final Rule definition is slightly narrower, because it requires the lamp to have the “highest radiant power peaks” in the IR region, rather “radiating predominantly” in the region. The DOE Final Rule definition that the Energy Commission should adopt is as follows:

“Infrared lamp” means a lamp that is designed and marketed as an infrared lamp; has its highest radiant power peaks in the infrared region of the electromagnetic spectrum (770 nm to 1 mm); has a rated wattage of 125 watts or greater; and which has a primary purpose of providing heat.

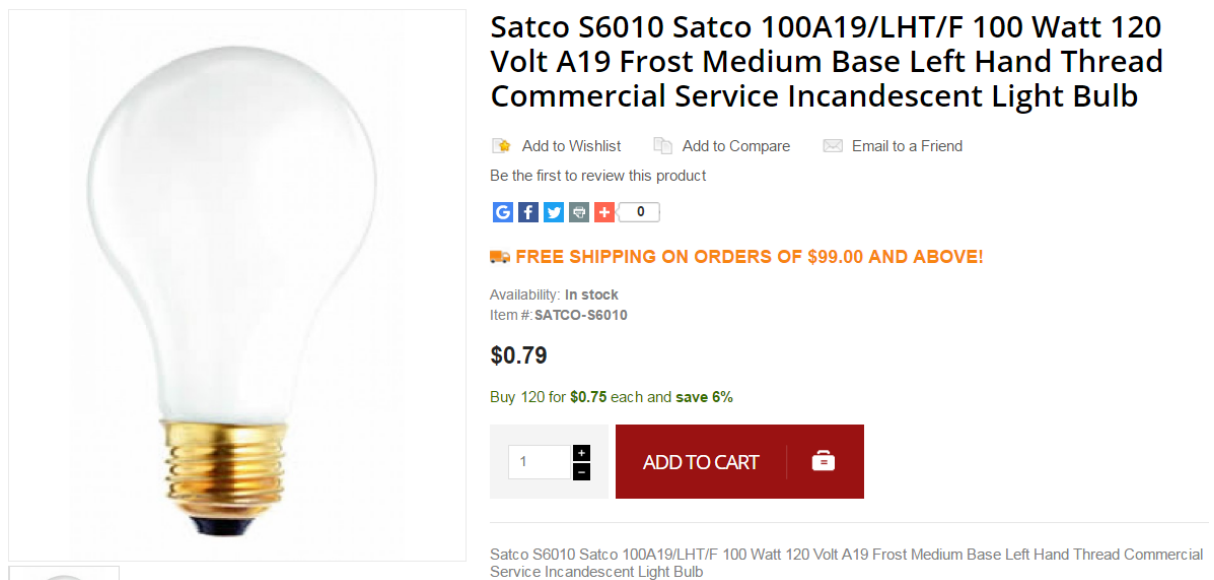
4.1.5 Left-Hand Thread Lamps

Left-hand, or left-handed, thread lamps are defined by the direction in which the lamp screwed into the lamp socket. These lamps are otherwise identical to their standard, right-hand counterparts. The primary utility for left-hand lamps is to serve as mild theft deterrent.

Title 20 defines these lamps as follows:

“Left-handed thread lamp” means a lamp on which the base screws into a lamp socket in a counter-clockwise direction, and screws out of a lamp socket in a clockwise direction.

This definition is already similar to the DOE Final Rule definition, and will not require any change from the Energy Commission. However, the Statewide CASE Team included this lamp type to highlight loophole concerns that may arise from the exemption. Since left-hand thread lamps are technologically identical to standard lamps, the Energy Commission should consider regulating these lamps. Additionally, the Statewide CASE Team found these lamps to currently be sold at very low prices, as shown in Figure 4.5. This exemption could grant incandescent lamps a pathway for coexisting with LED lamps, particularly for nostalgic or decorative purposes.



Satco S6010 Satco 100A19/LHT/F 100 Watt 120 Volt A19 Frost Medium Base Left Hand Thread Commercial Service Incandescent Light Bulb

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Satco S6010 Satco 100A19/LHT/F 100 Watt 120 Volt A19 Frost Medium Base Left Hand Thread Commercial Service Incandescent Light Bulb

Figure 4.5. An example of an incandescent left-hand thread lamp available online for \$0.79

Source: Bulbs.com. <http://www.bulbs.com/product/100A-LHT-LEFT-HAND-THREAD>

4.1.6 Silver Bowl Lamps



Figure 4.6. An LED silver bowl lamp

Source: Topbulb. <http://www.topbulb.com/martek-6w-a19-silver-bowl-led-60w-equal-warm-white-medium-base>

Silver bowl lamps are designed for decorative purposes. The silver coating on the head of the bulb serves as a mirror that reflects light towards the base, illuminating the reflective surfaces of the fixtures there are installed in, thereby producing a less direct, more diffuse light source.

Technologically, they are no different from standard bulbs, having similar shapes, brightness, and costs. Like with standard A-type lamps, LED versions of silver bowl lamps are widely available, as shown in Figure 4.6.

Title 20 defines these lamps as follows:

“Silver Bowl lamp” means a lamp that has a reflective coating applied directly to part of the bulb surface and that reflects light in a backward direction toward the lamp base. The designation shall be on the lamp packaging, and marketing materials shall identify the lamp as being a silver bowl lamp or similar designation.

Conversely, the DOE Final Rules definition for these lamps is more specific, because it requires them to have an opaque reflective coating. DOE believed that defining the reflective coating to be opaque will prevent these lamps from being able to serve as replacement GSILs. The DOE Final Rules definition is as follows:

“Silver bowl lamp” means a lamp that has an opaque reflective coating applied directly to part of the bulb surface that reflects light toward the lamp base and that is designed and marketed as a silver bowl lamp.

4.1.7 Traffic Signal Lamps

Traditional traffic signal lamps are A-shape, E-26 medium base incandescent lamps, can cost under \$2.00, and be used for general service lighting. These lamps are thus likely candidates for becoming loophole products. Manufacturers have argued that these lamps trade lighting performance for

longer lifetime. However, the Statewide CASE Team has found that LED A-shape lamps can easily meet the lighting performance and lifetime requirements of these product types without sacrificing efficacy.

Title 20 defines these lamps as follows:

“Traffic signal lamp” means a lamp that is designed with lifetime, wattage, focal length, filament configuration, mounting, lamp glass, and lamp base characteristics appropriate for use in traffic signals.

The DOE Final Rules definition specifically states that the lifetime of these lamps must be 8,000 hours or greater:

“Traffic signal lamp” means a lamp that is designed and marketed for traffic signal applications and has a lifetime of 8,000 hours or greater.



Figure 4.7 – Examples of traffic signal lamps available from 1000bulbs.com²⁴ and topbulb.com²⁵ look like typical A-shape, E-26 medium base incandescent lamps

²⁴ <https://www.1000bulbs.com/product/67292/IN-0116A21TSSYL.html>

²⁵ <http://www.topbulb.com/ge-17968-69a21-60wm-ts-60w-120v-a21-incandescent-traffic-signal>

4.1.8 G-Shaped Lamps Larger than 5-Inch in Diameter (G40)



Figure 4.8. An LED globe lamp of 5-inch diameter (G40)

Source: 1000 Bulbs. <https://www.1000bulbs.com/product/184458/PLT-10540.html>

Globe lamps with diameters greater than or equal to 5 inches are excluded from the GSL definition. However, the Statewide CASE Team identified several G-shaped lamps of 5 inches or greater that currently have more-efficient LED counterparts, as shown in Figure 4.8. Through browsing web retailers, the Statewide CASE Team found that G40 lamps often exist with diameters that are *around* 5 inches, with some G40 lamps being smaller than 5 inches (e.g., 4.75 inches) and some being larger, despite being marketed as G40 shape (i.e., 40/8 or 5 inches in diameter). Figure 4.9 shows the distribution of G-shaped bulbs available through one retailer. Since G40 bulbs are also available as LED technology, the Energy Commission should consider regulating these.

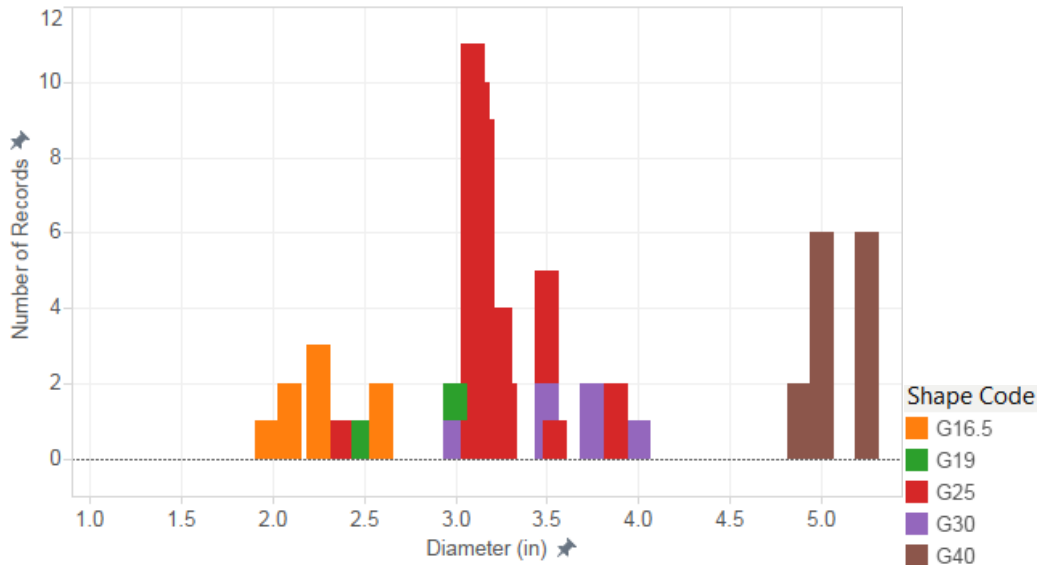


Figure 4.9. Distribution of G-Shaped lamps through one online retailer

Source: The Statewide CASE Team

4.1.9 Low-Lumen Lamps

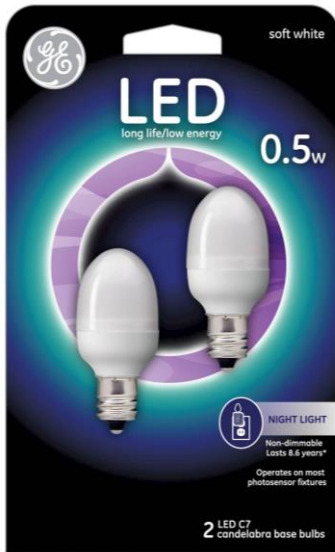


Figure 4.10. An LED night light

Source: Target. <https://www.target.com/p/ge-led-2-watt-nightlight-light-bulb-2-pack-soft-white-white-bulb/-/A-13783767>

As reported in Section 2.1, the DOE Final Rules definition for GSLs does not include lamps that have light output values that are less than 310 lumens (or 232 lumens for modified spectrum general service incandescent lamps). Such lamps are typically used for decorative purposes, or often advertised as night lights (Figure 4.10). The Statewide CASE Team believes that the Energy Commission should consider an efficacy requirement of 45 lm/W for low-lumen lamps since these lamps are technologically identical to GSLs. The incandescent versions of low-lumen lamps offer no additional utility when compared to the LED versions, which are as abundant as any of the product classes presented in this response.

In addition, the Title 20 standards for State-Regulated LED Lamps will apply to lamps that have light output values that are as low as 150 lumens. Without standards for all low-lumen lamps, the market for these lamps may shift towards inefficient incandescent technology in order to bypass Title 20 standards. Thus, the Statewide CASE Team believes that the Energy Commission should cover all low-lumen lamps by defining these lamps as follows:

“Low-Lumen Lamp” means a lamp that has an initial lumen output less than 310 lumens (or 232 lumens for modified spectrum general service incandescent lamps).

5. Statewide Energy Savings Assumptions

To estimate statewide energy savings, the Statewide CASE Team suggests that CEC use the hours of operation values determined by Lawrence Berkeley National Labs (LBNL) in the report entitled “Impact of the EISA 2007 Energy Efficiency Standard on General Service Lamps” [LBNL 2017]. The LBNL team calculated these values for representative lamp types by modifying an analysis performed in DOE’s GSL NOPR [DOE 2016a], which considered a distribution of operating hours by room type for GSLs, using a study commissioned by the California Public Utilities Commission that looked at more than 60,000 residential light sockets in California. The resulting hours for reflector lamps, small-screw-base lamps, MR lamps, and globe-shaped lamps are shown in Table 5.1.

Table 5.1. Average Daily Hours of Use by Lamp Type and Sector

Lamp Type	Residential	Commercial
MSB Reflector	2.9	10.7
MR	2.9	10.7
Decorative	2.6	10.7
Misc. A-type	2.3	10.7
Globe-shaped	1.7	10.7

To calculate peak demand the Energy Commission should multiply the average electricity demand by a load factor of 72 percent. A load factor is the ratio of average annual load to coincident peak load. The Statewide CASE Team obtained end-use load factors through consultations with the Energy Commission. The load factors used in this response were developed by the Energy Commission using an Hourly Energy and Load Model (HELM) [Koomey and Brown 2002] on 2013 utility-level energy demand data. This represents an increase from the 64 percent value commonly used from a 2002 report that uses data from 2001. A complete table of updated values for several end-uses is included in Appendix B.

6. Economic Analysis Background

When assessing cost-effectiveness of the expanded scope rulemaking for GSLs, the Energy Commission should consider the declining prices of LED lamps and the trend towards higher efficacy LED lamps. The Statewide CASE Team has compiled recent pricing data collected for LED lamps by collecting thousands of price points from nine online retailers at least once a month since 2013. Collectively, about 1,600 unique price points are collected in each data pull, for a total data stream of over 50,000 price points for relevant LED products.

The Statewide CASE Team analyzed this price data to understand trends and price-performance relationships in LED lamps. Although average online retail prices are often slightly higher than corresponding average in-store prices (presumably because higher priced products may remain offered for sale online while brick and mortar retailers may be more proactive about offering only the best prices), this analysis is very effective at identifying trends. Table 6.1 shows the absolute and percent change in average unit price for LED lamps greater than 300 lumens, from December 2013 to April 2016. The highest efficacy bin prices have dropped by at least 30 percent since late 2013. Table 6.2 shows the relative number of products available over time in each efficacy bin.

Table 6.1. Absolute and Percent Changes in Average Unit Prices of LED Lamps from December 2013 to April 2016

All LED lamps >300 lumens, by efficacy bin			
Efficacy Bin	Average Unit Price		% Change
	Dec. 2013	Apr. 2016	
40-50 lm/W	\$35.51	\$31.56	-11%
50-60 lm/W	\$33.93	\$27.76	-18%
60-70 lm/W	\$34.03	\$18.81	-45%
70-80 lm/W	\$32.37	\$15.48	-52%
80-90 lm/W	\$26.69	\$14.23	-47%
90-100 lm/W	\$33.99	\$15.41	-55%
100+ lm/W	\$36.09	\$25.33	-30%

Table 6.2. Changes in Availability of Products by Efficacy Level From December 2013 to April 2015

All LED lamps >300 lumens, by efficacy bin			
Efficacy Bin	# of Products		% Change
	Dec. 2013	Apr. 2016	
40-50 lm/W	169	74	-56%
50-60 lm/W	562	351	-38%
60-70 lm/W	545	626	15%
70-80 lm/W	239	623	161%
80-90 lm/W	55	248	351%
90-100 lm/W	5	78	1,460%
100+ lm/W	1	59	5,800%

Figure 6.1 shows price per kilolumen trends for LED lamps, with the highest efficacy products showing lower pricing. Trend lines show prices falling to less than \$5 per kilolumen in the highest efficacy ranges by 2020.

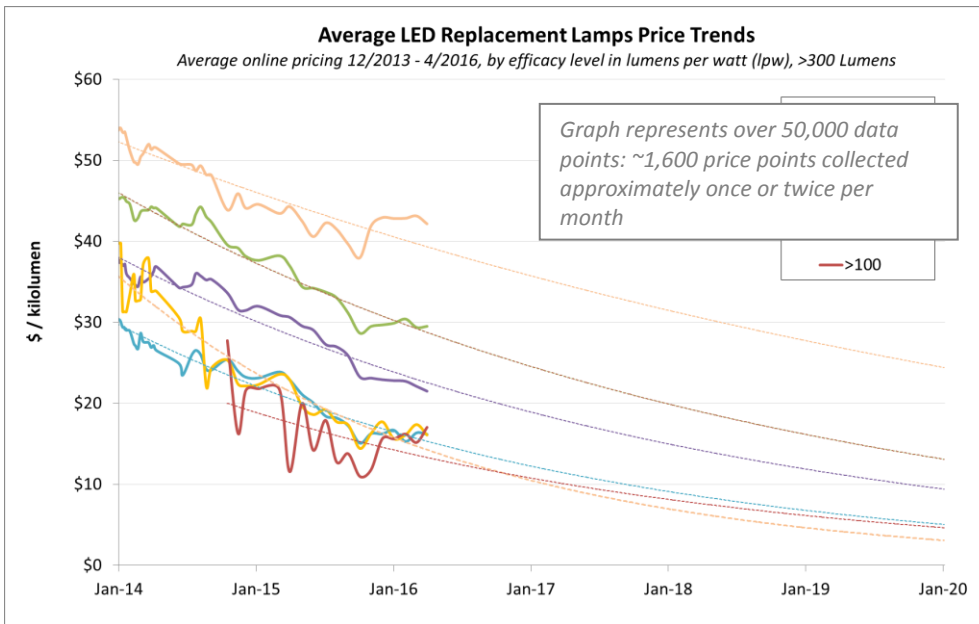


Figure 6.1. Time series trend of LED lamp per kilolumen pricing, by efficacy bin (lm/W)

Figure 6.2 below shows price per unit trends of omnidirectional LED lamps by efficacy bin. Trend lines show per unit average pricing dropping below \$3 per kilolumen for high efficacy omnidirectional lamps by 2020.

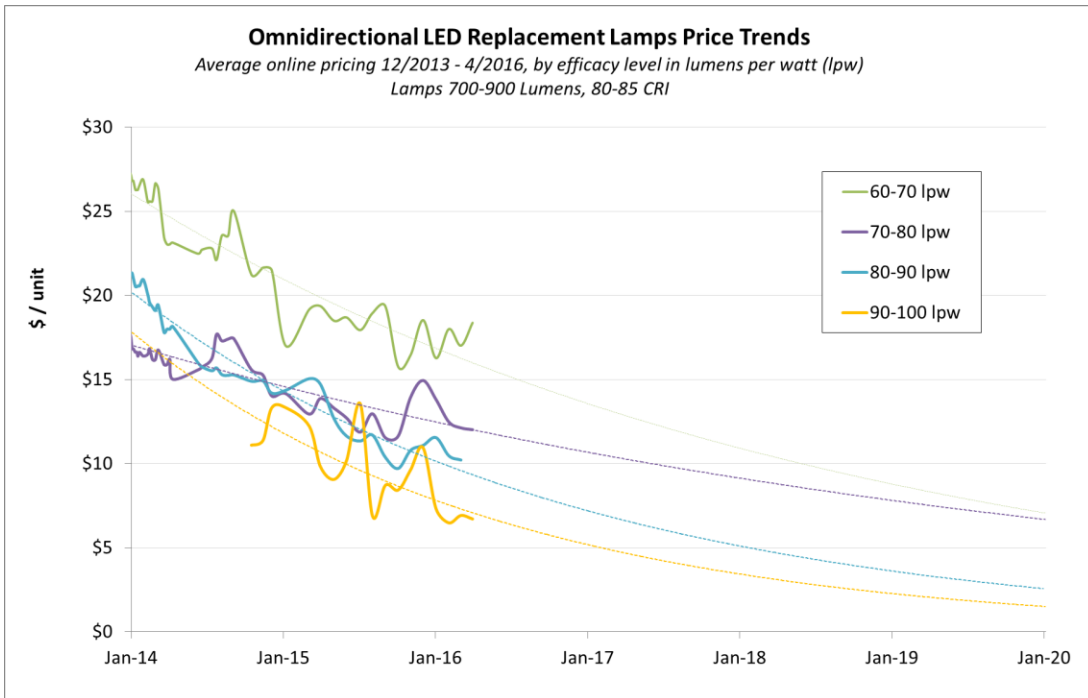


Figure 6.2. Time series trend of omni-directional LED lamp per unit pricing, by efficacy bin (lm/W)

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Appendix A: Electricity Rates

The electricity rates used in the analysis presented in this response were derived from projected future prices for residential, commercial and industrial sectors in the Energy Commission’s “Mid-case” projection of the 2014-2024 Demand Forecast (CEC 2013), which used a three percent discount rate and provide prices in 2012 dollars. The sales weighted average of the 5 largest utilities in California was converted to 2017 dollars using an inflation adjustment of 1.04 (DOL 2013). See the rates by year below in Table A.1

Table A.1: Statewide Sales Weighted Average Residential Electricity Rates 2017 – 2026 (PG&E, SCE, SDG&E, LADWP and SMUD - 5 largest Utilities) in 2017 cents/kWh

Year	Residential Electricity Rate (2017 cents/kWh)
2017	17.40
2018	17.65
2019	17.86
2020	18.08
2021	18.26
2022	18.44
2023	18.60
2024	18.74
2025	18.88
2026	19.02
2027	19.16
2028	19.31
2028	19.48

Appendix B: Load Factors

2013 Electricity Consumption and Peak Demand for The Top 5 California Utilities^a

Sector & End-Use	Coincident Load		Annual Energy		Load Factor ^b
	MW	% of Total	GWh	% of Total	
Residential					
Cooking	581.4	1%	2,833.1	1%	56%
Clothes Dryer	759.4	1%	4,419.5	2%	66%
Dishwasher	211.1	0%	2237	1%	121%
Freezer	302.4	1%	2,132.1	1%	80%
Miscellaneous	2,849.3	5%	23,139.9	9%	93%
Multi-Family Water Heater	114.2	0%	1,189.4	0%	119%
Pool Heater	33.0	0%	155.6	0%	54%
Pool Pump	769.3	1%	3,689.7	1%	55%
Refrigerator	1,736.4	3%	13,996.2	5%	92%
Solar Water Heat - Back-up	0.0	0%	0.2	0%	63%
Solar Water Heat - Pump	0.8	0%	2.3	0%	31%
Spa Heater	64.9	0%	247.6	0%	44%
Spa Pump	261.5	0%	990.4	0%	43%
Single Family Water Heater	196.5	0%	1,709.6	1%	99%
Television	807.2	1%	6003	2%	85%
Waterbed Heater	737.0	1%	12,003.7	5%	186%
Clothes Washer	122.2	0%	824.6	0%	77%
Air Conditioning	15,739.6	28%	8,378.51	3%	6%
Space Heating	0.0	0%	3,441.46	1%	0%
Commercial					
Other	3,344.8	6%	23,762.2	9%	81%
Domestic Hot Water	144.5	0%	675.7	0%	53%
Cooking	94.5	0%	721.9	0%	87%
Office Equipment	263.3	0%	1,699.2	1%	74%
Refrigeration	888.4	2%	7,872.6	3%	101%
Exterior Lighting	40.9	0%	5,909.2	2%	1649%
Interior Lighting	4,856.2	9%	30,686.2	12%	72%
Ventilation	1,787.3	3%	10,366.1	4%	66%
Air Conditioning	7,714.7	14%	15,724.95	6%	23%
Space Heating	0.0	0%	2,702.77	1%	0%
Subtotal	19,134.6	34%	100,120.82	38%	60%

Source: CEC Demand Analysis Office (Tian, 2016)

^a The Top 5 California Utilities are Pacific Gas & Electric (PG&E), San Diego Gas & Electric (SDG&E), Southern California Edison Company (SCE), Sacramento Municipal Utility District (SMUD), and Los Angeles Department of Water and Power (LADWP).

^b Load Factor is the ratio of average annual load to coincident peak load. The load factors for commercial exterior lighting and residential waterbed heaters are very high because their consumption is mainly off-peak.

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