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State of California **California Natural Resources Agency**

M e m o r a n d u m

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Telephone: (916) 654-4274

From: **Patrick Saxton, Senior Electrical Engineer**
Appliances Office, Efficiency Division
California Energy Commission
1516 Ninth Street
Sacramento CA 95814-5512

Subject: **Supplemental Staff Analysis for General Service Lamps (Expanded Scope)**

INTRODUCTION

On August 3, 2018, Energy Commission staff published *Analysis of General Service Lamps (Expanded Scope)*.[1] This draft staff report included staff's analysis and conclusions supporting a finding of technical feasibility and cost-effectiveness for a minimum efficacy standard of 45 lumens-per-watt for a broad range of lamps (light bulbs). Feedback received at an August 28, 2018, staff workshop and in written comments suggested that staff's assumption for the 2017 existing stock of low-efficacy lamps was too high and did not properly represent the number of high-efficacy light-emitting diode (LED) lamps installed in California. Feedback also suggested that staff's assumption for the 2017 shipments of LED lamps was too low and did not properly represent the growing market share of LEDs. None of the stakeholders who suggested the staff estimates were too conservative submitted specific data on LED populations, sales, or shipments to the Commission.

The specific benefits from the federal minimum efficacy standard of 45 lumens-per-watt[2] and the federal definition of general service lamps[3], which staff's proposed regulations are meant to ensure take place regardless of potential changes at the federal level, are utility bill cost savings to the consumer and lower statewide energy use. No additional energy savings benefits or incremental costs will result directly from the proposed regulations, beyond those that would result from existing federal law and regulations effective January 1, 2020. The estimated savings in the draft staff report and in this supplemental staff analysis are those expected to occur in California due to existing federal law and regulations effective January 1, 2020, for lamps not already covered by California efficiency standards. The estimated savings are highly dependent on the current population of efficient lamps in California.

This supplemental staff analysis provides an additional scenario (high LED scenario) for statewide energy and monetary savings using assumptions of lower 2017 existing

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[1] Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=224408&DocumentContentId=54683.
[2] 42 U.S.C. § 6295(i)(6)(A)(v).
[3] 82 FR 7276 (Jan. 19, 2017) and 82 FR 7322 (Jan. 19, 2017).

stock of low-efficacy lamps and higher 2017 shipments of LED lamps.[4] The result is a large range of estimated statewide annual electricity savings and annual net monetary savings, because the number of low-efficacy lamps replaced under a 45 lumens-per-watt minimum efficacy standard is highly dependent on the assumptions of existing stock and shipments. Staff estimates that 258 million low-efficacy lamps would be replaced under the standard in the low LED scenario. Under the high LED scenario, the estimated number of low-efficacy lamps replaced under the standard is reduced to 81.7 million. The range of estimated statewide savings does not alter staff's findings related to technical feasibility and cost-effectiveness, which are necessary conditions required by the Public Resources Code, §25402(c)(1) when the Commission considers adoption of appliance efficiency regulations.

ASSUMPTIONS FOR LOW LED SCENARIO

For the low LED scenario, information from Chapter 8 and Appendix A of the draft staff report is repeated here for convenience. Calculations are detailed in Appendix A of the draft staff report.

For the low LED scenario, staff began with its estimate of shipments share by light source technology in 2017 (**Table** 1) and the estimate of California existing stock of low-efficacy lamps in 2017 (**Table 2)** from the *General Service Lamps (Expanded Scope) CASE Initiative*.

Table 1: Estimate of Shipments Share by Light Source Technology in 2017 for Low LED Scenario

	Low LED Scenario	
Lamp Type	**Incandescent**	**LED**
Large Diameter Reflector Lamps	80%	20%
Decorative Lamps	85%	15%
Globe Lamps	90%	10%
EISA-Exempt Lamps	100%	0%

Source: Energy Commission staff

Table 2: Estimate of California Existing Stock of Low-Efficacy Lamps for Low LED Scenario (millions)

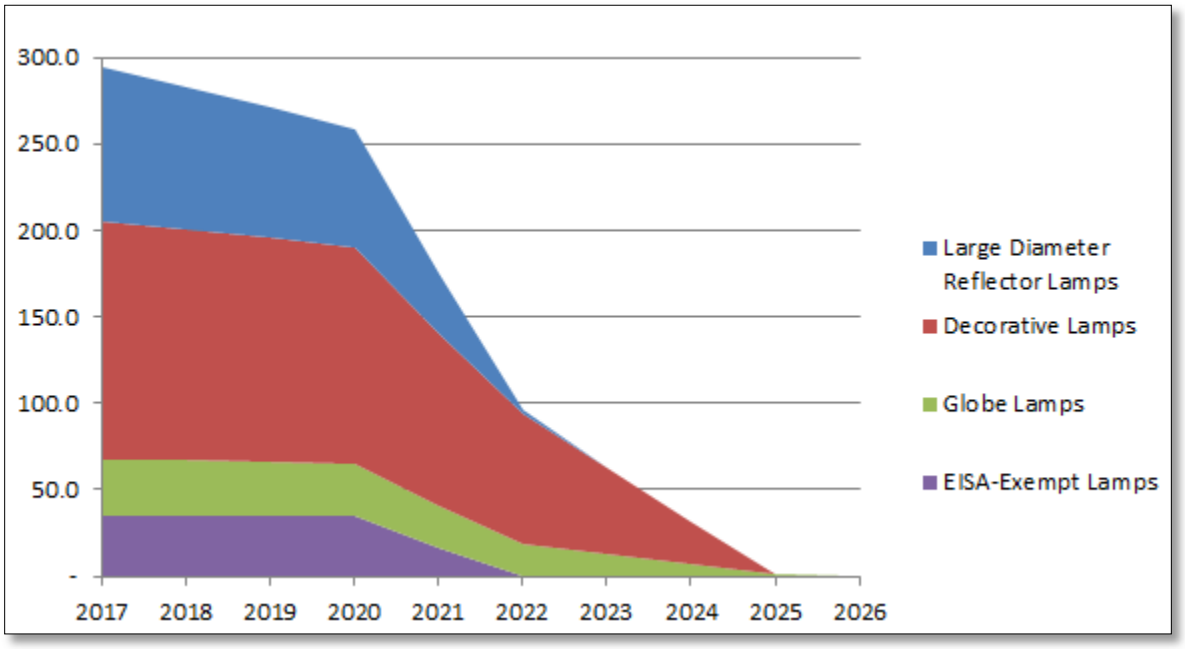
Lamp Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Large Diameter Reflector Lamps	88.8*	82.3	75.2	67.4	35.0	2.6	-	-	-	-
Decorative Lamps	137.6*	133.9	129.7	125.2	100.2	75.2	50.2	25.2	0.2	-
Globe Lamps	32.4*	31.8	31.2	30.4	24.5	18.6	12.7	6.8	0.9	-
EISA-Exempt Lamps	35.0*	35.0	35.0	35.0	15.9	-	-	-	-	-

Source: Energy Commission staff and General Service Lamps (Expanded Scope) CASE Initiative*

Staff reduced the existing stock of low-efficacy lamps in subsequent years by the estimated number of replacement LED lamps shipped each year. The estimate of California existing stock of low-efficacy lamps for the years 2017 to 2026 for the low LED scenario is shown in **Figure** 1.

[4] Low-lumen lamps have been removed from the scope of the proposed regulations for general service lamps and are not included in this supplemental analysis.

Figure 1: Estimate of California Existing Stock of Low-Efficacy Lamps for Low LED Scenario (millions)



Source: Energy Commission staff

Staff estimated the number of replacement LED lamps by multiplying the estimate of California shipments of replacement lamps for the standards case (**Table 3**) by the shipments share for LED lamps and applying a 10 percent multiplier to the shipments share in 2018 and 2019 to reflect additional increases in LED market share. For example, large-diameter reflector LED lamps have shipment shares of 22 percent in 2018 and 24.2 percent in 2019. Beginning in 2020, the year the minimum efficacy standard would become effective, shipments are assumed to be entirely composed of LED lamps, and the stock of incandescent lamps begins to decline rapidly. Shipments also decline year over year because of the longer lifetime of LED lamps, resulting in fewer purchases of replacement lamps over time. The estimate for shipments of replacement lamps includes only the initial replacement of a low-efficacy lamp and does not include any subsequent replacement of a high-efficacy lamp, shipments for lamps in new construction, or other new lamps.

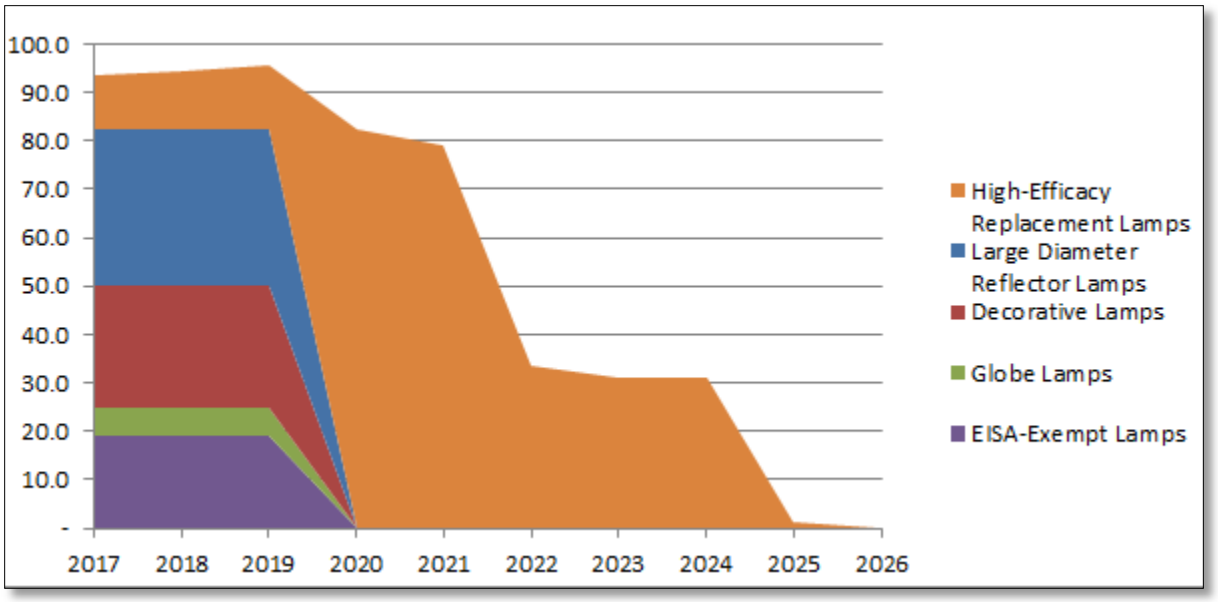
Table 3: Estimate of California Shipments of Replacement Lamps for Standards Case for Low LED Scenario (millions)

Lamp Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Large Diameter Reflector Lamps	32.4*	32.4	32.4	-	-	-	-	-	-	-
Decorative Lamps	25.0*	25.0	25.0	-	-	-	-	-	-	-
Globe Lamps	5.9*	5.9	5.9	-	-	-	-	-	-	-
EISA-Exempt Lamps	19.1*	19.1	19.1	-	-	-	-	-	-	-
High-Efficacy Replacement Lamps	11.3	11.9	13.1	82.4	79.2	33.5	30.9	30.9	1.1	-

Source: Energy Commission staff and General Service Lamps (Expanded Scope) CASE Initiative*

The estimate of California shipments of replacement lamps for the standards case for 2017 to 2026 for the low LED scenario is shown in **Figure 2**.

Figure 2: Estimate of California Shipments of Replacement Lamps for Standards Case for Low LED Scenario (millions)



Source: Energy Commission staff

ASSUMPTIONS FOR HIGH LED SCENARIO

For the high LED scenario, staff significantly increased its estimate of shipments share in 2017 for LED lamps (**Table 4**).

Table 4: Estimate of Shipments Share by Light Source Technology in 2017 for High LED Scenario

	High LED Scenario	
Lamp Type	**Incandescent**	**LED**
Large Diameter Reflector Lamps	50%	50%
Decorative Lamps	70%	30%
Globe Lamps	70%	30%
EISA-Exempt Lamps	70%	30%

Source: Energy Commission staff

Staff reduced the estimate of California existing stock of low-efficacy lamps by assuming that LED lamps were 50 percent of the California existing stock of lamps in 2017. Staff used the low LED scenario estimate of shipments share for incandescent lamps in 2017 as a proxy for the percent of incandescent lamps in the 2017 existing stock of lamps (e.g., 80 percent for large diameter reflector lamps). Staff calculated an estimate of the total number of existing lamps in 2017 by diving the low LED scenario estimate of the existing stock of low-efficacy lamps by this proxy (e.g., for large diameter reflector lamps 88.8 million ÷ 0.8 = 111 million lamps). Staff then reduced this estimate by half in order to represent a 50 percent share of LED lamps in the 2017 stock (e.g., for large diameter reflector lamps 111 million x 0.5 = 55.5 million

lamps). The resulting estimates of California existing stock of low-efficacy lamps for the high LED scenario are shown in **Table 5**.

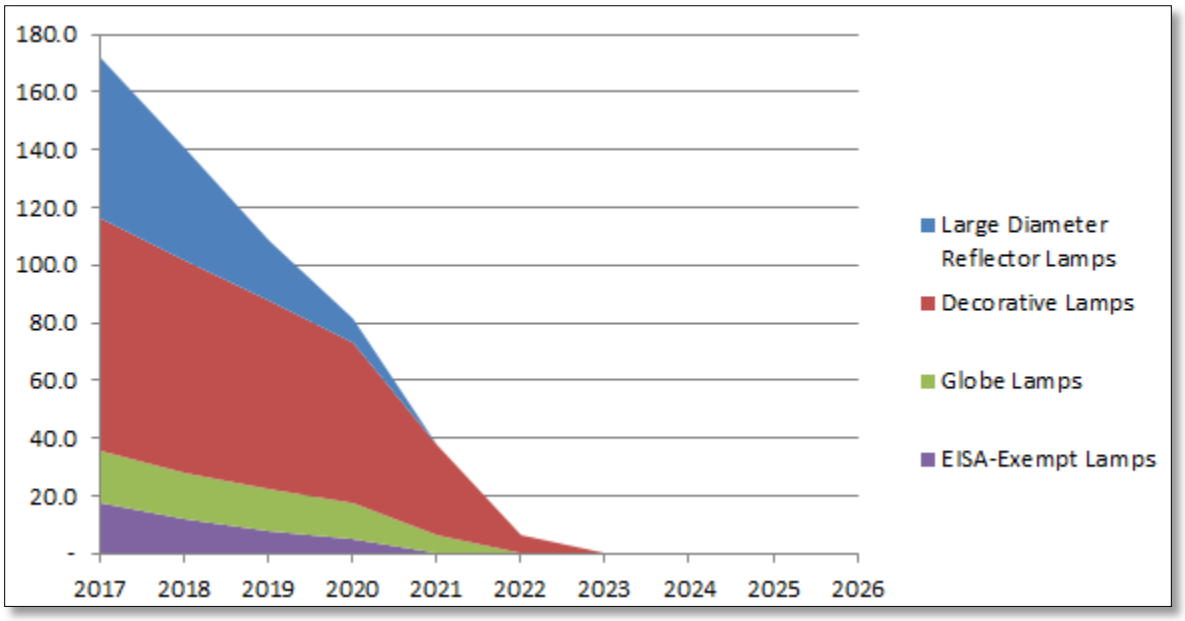
Table 5: Estimate of California Existing Stock of Low-Efficacy Lamps for High LED Scenario (millions)

Lamp Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Large Diameter Reflector Lamps	55.5	39.3	21.5	8.5	-	-	-	-	-	-
Decorative Lamps	80.9	73.4	65.2	56.1	31.1	6.1	-	-	-	-
Globe Lamps	18.0	16.2	14.3	12.1	6.2	0.3	-	-	-	-
EISA-Exempt Lamps	17.5	11.8	7.9	5.0	-	-	-	-	-	-

Source: Energy Commission staff

Staff reduced the existing stock of low-efficacy lamps in subsequent years in the same manner as previously described but using the increased estimate of replacement LED lamps shipped each year. The estimate of California existing stock of low-efficacy lamps for the years 2017 to 2026 for the high LED scenario is shown in **Figure 3**.

Figure 3: Estimate of California Existing Stock of Low-Efficacy Lamps for High LED Scenario (millions)



Source: Energy Commission staff

Staff estimated the number of California shipments of replacement lamps for the standards case the high LED scenario in the same manner as previously described but using the increased estimate of replacement LED lamps shipped each year. The results are shown in **Table 6**. Because of the reduced number of low-efficacy lamps replaced under the standard, the higher shipments of LEDs, and the estimate only including the initial replacement of a low-efficacy lamp, shipments of replacement lamps are reduced to zero much more quickly in the high LED scenario.

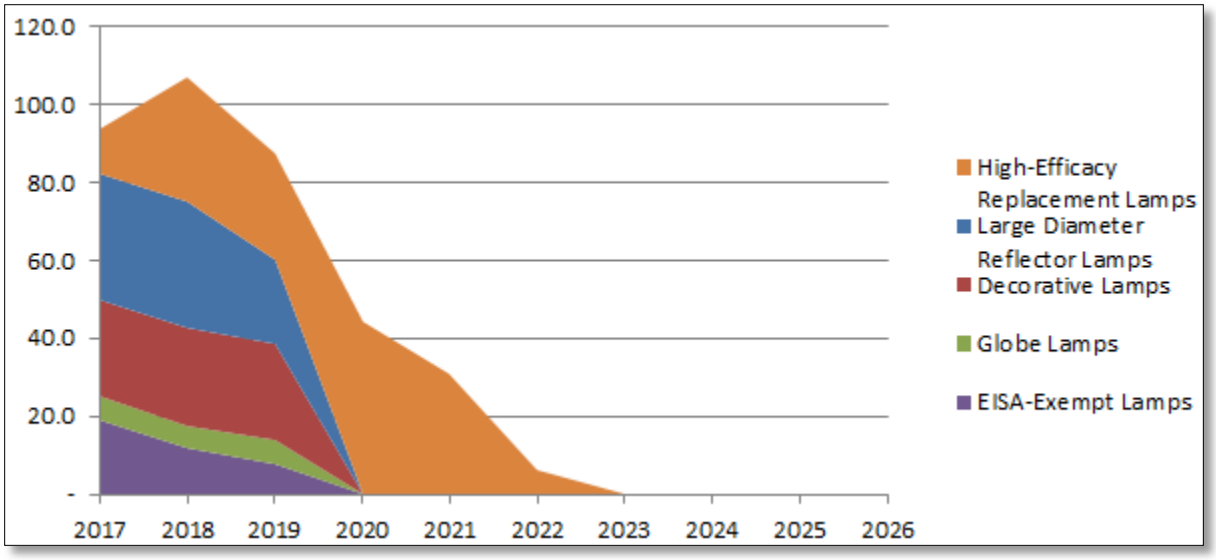
Table 6: Estimate of California Shipments of Replacement Lamps for Standards Case for High LED Scenario (millions)

Lamp Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Large Diameter Reflector Lamps	32.4	32.4	21.5	-	-	-	-	-	-	-
Decorative Lamps	25.0	25.0	25.0	-	-	-	-	-	-	-
Globe Lamps	5.9	5.9	5.9	-	-	-	-	-	-	-
EISA-Exempt Lamps	19.1	11.8	7.9	-	-	-	-	-	-	-
High-Efficacy Replacement Lamps	11.3	31.9	27.1	44.4	30.9	6.4	-	-	-	-

Source: Energy Commission staff

The estimate of California shipments of replacement lamps for the standards case for 2017 to 2026 for the high LED scenario is shown in **Figure 4**.

Figure 4: Estimate of California Shipments of Replacement Lamps for Standards Case for High LED Scenario (millions)



Source: Energy Commission staff

SAVINGS FOR LOW AND HIGH LED SCENARIOS

The single compliant lamp electricity savings (**Table 7**) and net monetary savings (**Table 8**) information from Chapter 8 and Appendix A of the draft staff report is repeated here for convenience. Calculations are detailed in Appendix A of the draft staff report.

Table 7: Single Compliant Lamp Electricity Savings

Lamp Type	Electricity Savings (kWh)	
	Annual	Lifecycle
Large Diameter Reflector Lamps	59.7	508.9
Decorative Lamps (average)	50.7	407.2
Globe Lamps	31.2	328.9
EISA-Exempt Lamps	66.2	497.8

Source: Energy Commission staff

Table 8: Single Compliant Lamp Net Monetary Savings

Lamp Type	Net Monetary Savings	
	First-year	Lifecycle
Large Diameter Reflector Lamps	$9.96	$90.90
Decorative Lamps (average)	$4.60	$61.00
Globe Lamps	$1.65	$50.69
EISA-Exempt Lamps	-$3.16	$54.64

Source: Energy Commission staff

The statewide annual electricity and annual net monetary savings for the low LED scenario (**Table 9**) from Chapter 8 and Appendix A of the draft staff report is repeated here for convenience. Calculations are detailed in Appendix A of the draft staff report

Table 9: Statewide Annual Electricity and Annual Net Monetary Savings for Low LED Scenario

Lamp Type	Annual Electricity Savings (GWh)		Annual Net Monetary Savings ($millions)	
	First-Year	After Full Stock Turnover	First-Year	After Full Stock Turnover
Large Diameter Reflector Lamps	1,933	4,018	$323	$738
Decorative Lamps (average)	1,267	6,345	$115	$1,149
Globe Lamps	184	950	$10	$172
EISA-Exempt Lamps	1,265	2,317	-$60	$414
Total	4,649	13,631	$387	$2,474

Source: Energy Commission staff

Staff calculated the statewide annual electricity and annual net monetary savings for the high LED scenario (**Table 10**) by multiplying the appropriate single compliant lamp savings by the estimated 2020 shipments and the estimated 2020 existing stock, respectively.

Table 10: Statewide Annual Electricity and Annual Net Monetary Savings for High LED Scenario

Lamp Type	Annual Electricity Savings (GWh)		Annual Net Monetary Savings ($millions)	
	First-Year	After Full Stock Turnover	First-Year	After Full Stock Turnover
Large Diameter Reflector Lamps	506	506	$85	$93
Decorative Lamps (average)	1,267	2,842	$115	$515
Globe Lamps	184	379	$10	$69
EISA-Exempt Lamps	333	333	-$16	$59
Total	2,290	4,060	$193	$736

Source: Energy Commission staff

CONCLUSION

The specific benefits from the federal minimum efficacy standard of 45 lumens-per-watt and the federal definition of general service lamps, which staff's proposed regulations are meant to ensure take place regardless of potential changes at the federal level, are utility bill cost savings to the consumer and lower statewide energy use. No additional energy savings benefits or incremental costs will result directly from the proposed regulations, beyond those that would result from existing federal law and regulations effective January 1, 2020. The estimated savings in the draft staff report and in this supplemental staff analysis are those expected to occur in California due to existing federal law and regulations effective January 1, 2020, for lamps not already covered by California efficiency standards. The estimated savings are highly dependent on the current population of efficient lamps in California.

This memo supplements the scenario in the draft staff report (low LED scenario) with an additional scenario (high LED scenario) to reflect stakeholder feedback stating that staff's initial assumptions about LED lamps were too conservative. This results in a large range of estimated statewide annual electricity savings and annual net monetary savings but does not alter staff's findings related to technical feasibility and cost-effectiveness, which are necessary conditions required by the Public Resources Code, §25402(c)(1) when the Commission considers adoption of appliance efficiency regulations.

Under the low LED scenario, an estimated 258 million lamps would be replaced under a minimum efficacy standard of 45 lumens-per-watt, resulting in first year electricity savings of 4,649 GWh and first year net monetary savings of $387 million. After full stock turnover, annual electricity savings would be 13,631 GWh and annual net monetary savings would be $2.474 billion.

Under the high LED scenario, an estimated 81.7 million lamps would be replaced under a minimum efficacy standard of 45 lumens-per-watt, resulting in first year electricity savings of 2,290 GWh and first year net monetary savings of $193 million. After full stock turnover, annual electricity savings would be 4,060 GWh and annual net monetary savings would be $736 million.