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Upstream and Residential Downstream Lighting Impact Evaluation Report

Lighting Sector – Program Year 2017

EM&V Group A

CALIFORNIA PUBLIC UTILITIES COMMISSION

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Table of contents

List of figures

List of tables

List of Abbreviations

ANCOVA	Analysis of covariance
CF	Coincidence factor
CFL	Compact fluorescent lamp
CLASS	California Lighting and Appliance Saturation Survey
CREED	Consortium of Retail Energy Efficiency Data
DEER	Database for Energy-Efficient Resources
EISA	Energy Independence and Security Act (2007)
EM&V	Evaluation, Measurement, and Verification
ESPI	Energy Savings Performance Incentive
EUL	Effective useful life
GWh	Gigawatt hour
HOU	Hours of use
HVAC	Heating, ventilation, and air-conditioning
IE	Interactive effects
IESR	Impact Evaluation Standard Reporting
Inc	Incandescent
IOU	Investor-owned utility
kW	Kilowatt
kWh	Kilowatt hour
LCM	Lamp Choice Model
LED	Light-emitting diode
MR	Multifaceted reflector
MSB	Medium screw base
MW	Megawatt
MWh	Megawatt hour
NCP	National Consumer Panel
NTGR	Net-to-gross ratio
PA	Program administrator
PAR	Parabolic aluminized reflector
PL	Program lamp
POS	Point-of-sale
Q1	First quarter
Q2	Second quarter
Q3	Third quarter
Q4	Fourth quarter
UES	Unit energy savings
UPC	Universal Product Code
W	Watt
WO28	California Upstream and Residential Lighting Impact Evaluation Work Order 28

1 EXECUTIVE SUMMARY

This report presents the energy savings evaluation of the California investor-owned utilities' (IOU) 2017 upstream lighting programs funded by ratepayers. Upstream programs provide monetary incentives to manufacturers (and in some cases, retailers) to encourage deployment and stocking of energy-efficient technologies and, in this study, we are focused on lighting technologies mainly used in the residential sector. We should note there are also lighting rebate programs that provide incentives directly to utility customers that are also part of this study. DNV GL conducted this evaluation as part of the California Public Utilities Commission (CPUC) Energy Division (ED) Evaluation, Measurement & Verification contract.

For all upstream residential technologies, we present the energy savings and peak demand reductions that these technologies achieved relative to technologies that they displaced (gross savings), as well as the energy savings and peak demand reduction these technologies achieved directly due to the IOU program intervention (net savings). The energy savings and peak demand reductions from upstream residential technologies account for the majority of savings from the upstream lighting program.

1.1 Study background

This energy savings evaluation looks at a) all lighting technologies deployed using the upstream lighting program and b) lighting rebates offered for technologies deployed within the residential programs Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E), hereafter referred to as program administrators. It is notable that each program administrator's lighting program savings accounted for substantially different proportions of their respective overall portfolio savings in 2017. PG&E's upstream and lighting rebate programs accounted for 3% of their portfolio-wide net energy savings, while SCE's accounted for 15%, and SDG&E's accounted for 35% (see Table 1-1).

Table 1-1. Summary of program administrator-reported net annual savings from upstream lighting, 2017

PA	Program Administrator Reported Net Annual Savings					
	Total Portfolio		Upstream Lighting		Upstream Lighting as Percent of Total Portfolio	
	Energy (GWh)	Peak Demand Reduction (MW)	Energy (GWh)	Peak Demand Reduction (MW)	Energy (GWh)	Peak Demand Reduction (MW)
PG&E	1,340	291	39	6	3%	2%
SCE	1,364	254	208	28	15%	11%
SDG&E	440	80	155	22	35%	27%
Statewide	**3,143**	**625**	**401**	**55**	**13%**	**9%**

The upstream and residential downstream lighting programs have changed since the previous evaluation of the 2015 programs, and it is worth recognizing how the 2017 upstream and residential downstream lighting rebate programs' quantity of light bulbs and associated savings compare to 2015. As the Energy Division's workpaper review process continued to update the baselines to be more efficient than before, PG&E slightly reduced the overall magnitude of their upstream and residential downstream lighting rebate programs and slightly increased its discounted light bulb quantities (see Table 1-2). SCE reduced their overall savings estimates but increased the number of discounted light bulbs to achieve targeted savings. SDG&E implemented the most dramatic change, increasing their upstream and residential lighting rebate portfolio by nearly five-fold and estimated that these programs achieved 155 GWh net savings in 2017, compared to an estimated 33 GWh net savings in 2015. To report these savings, they discounted more than four times as many light bulbs in 2017 compared to 2015.

Table 1-2. Summary of program administrator-reported net annual energy savings and quantity of discounted light bulbs from upstream and residential downstream lighting rebates, 2015 and 2017

Program Year	Program Administrator Reported Net Energy Savings (GWh)				Quantity of Light bulbs			
	PG&E	SCE	SDG&E	Total	PG&E	SCE	SDG&E	Total
2015	44	212	33	**288**	3,440,260	10,258,827	2,019,998	**15,719,085**
2017	39	208	155	**401**	3,951,597	15,153,891	8,700,049	**27,805,537**

1.2 Technologies Evaluated

This evaluation focuses on four lighting technologies that account for 90% of the program administrators' reported net savings from the upstream lighting programs. The 2017 evaluation addresses two types of light-emitting diode (LED) light bulbs and two types of compact fluorescent light bulbs (CFL)[1]:

- LED "A-lamp" light bulbs of all wattages – These are the light bulbs you would find in your lamp at home.
- LED reflector light bulbs of all wattages – These are the type of light bulbs you would put in a recessed can in your kitchen ceiling.
- CFL basic spiral shape ⩽ 30 Watts – These are also the type of light bulbs you would find in your lamp at home.

[1] These two CFL measures were the only CFL measures that program administrators discounted in 2017.

- CFL high-wattage (> 30 Watts) – These are similar to the "spiral" CFL but just have a higher wattage.

The combined total light bulbs shipped from manufacturers to retail stores across the three program administrators was nearly 25 million (see Table 1-3). Overall, LED bulbs represent 84% of bulbs shipped in 2017 while CFLs comprised only 16%. LED reflectors made up a majority of bulbs (50%) across the program administrators and comprised the largest share of bulbs shipped within each program administrator. High wattage CFLs accounted for more than a quarter of the bulbs that SCE shipped in 2017 compared to only 3% of the bulbs that PG&E and SDG&E shipped.

Table 1-3. Quantity of light bulbs in evaluated upstream lighting measure groups by program administrator, 2017

Evaluated Upstream Lighting Measure Group	Quantity (Number of Light bulbs)			Overall Quantity (Across Program Administrators)	
	PG&E	SCE	SDG&E	Total	% of Total
CFL basic spiral ≤ 30 Watt	0	4,889	0	4,889	0%
CFL high-wattage (> 30 Watt)	81,000	3,697,743	252,408	4,031,151	16%
LED A-lamp, all wattages	887,750	4,331,310	3,176,299	8,395,359	34%
LED reflector, all wattages	1,398,633	6,430,941	4,473,070	12,302,644	50%
Overall	**2,367,383**	**14,464,883**	**7,901,777**	**24,734,044**	**100%**

1.3 Approach

The 2017 energy savings evaluation team used evaluation methodologies developed for the 2015 program evaluation with simplifications that preserve the value of the approach and improve transparency. We used methods consistent with the 2015 approach for net savings estimation with a modification of the gross savings baseline that simplifies the analysis and provides a more coherent market-based framework. The CPUC had contracts in place to study the 2015 program year and the current contract will study the 2017 program year. There are no evaluated savings for program year 2016 due to contracting delays.

We used a model[2] to determine the share of sales of different efficient and inefficient technologies with and without the upstream lighting program. We then calculate the proportion of program-discounted light bulbs that would not have been bought without the program and the corresponding wattages.

In any energy savings evaluation, establishment of the baseline – that is, what the energy use would have been in absence of the program – directly impacts the savings determination. For this evaluation, we applied a key simplification of the previous cycle's methodology: we used the average wattage of displaced purchases directly as the gross baseline. We then determined the net-to-gross ratios[3] for each technology to remove program-discounted light bulbs that would have sold in the absence of the program.

1.3.1 Shipment versus sales quantity adjustment

We reviewed the program administrator-submitted annual 2017 program data and found unusually large volumes of light bulbs shipped to many small stores in SCE and SDG&E territories. The reported number of

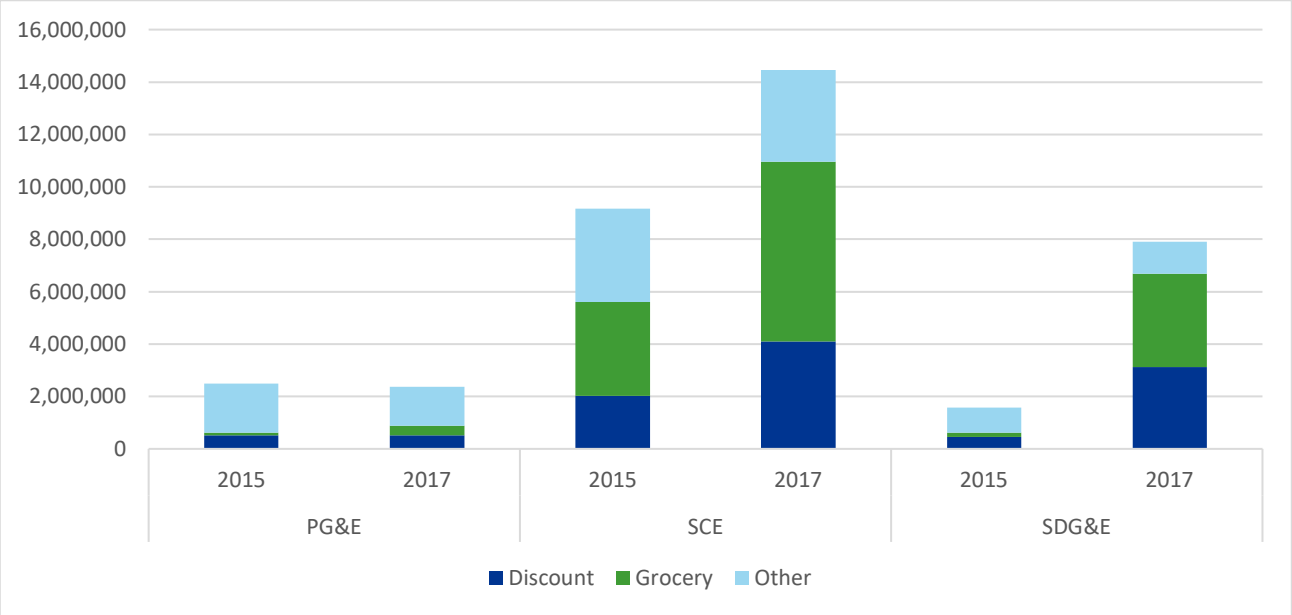
[2] The Lamp Choice Model is a set of assumptions and 'levers' to predict or simulate consumer choices with and without program intervention. It runs on 'R', the open-source statistics software. See Section 3.8 and Appendix F for further details on the Lamp Choice Model.

[3] Net-to-gross ratio is the ratio of energy savings that occurred due to the program intervention and the energy savings that would have occurred without any program intervention. It is indicative of the customers who would have purchased that same measure even without the program rebate ("free riders"). It ranges from 0 to 1. The higher the net-to-gross ratio, the more that the program influenced consumer choice.

light bulbs shipped to stores was significantly higher than the number of total California light bulb sales determined from other data sources.

Figure 1-1 shows the quantity of light bulbs shipped by sales channel (grocery store, discount store, etc.) and program administrator in 2015 and 2017. Overall, SCE increased the number of light bulbs it shipped by over 50% in 2017 compared to 2015, and SDG&E shipped approximately five times the number of light bulbs in 2017 than it did in 2015. Also notable is that SCE nearly doubled the number of light bulbs it shipped to discount and grocery stores in 2017, and SDG&E shipped more than ten times as many light bulbs to these two channels in 2017 compared to 2015.[4] Given these unusual volumes, the evaluation team investigated what percentage of shipped light bulbs were most likely sold.

Figure 1-1. Quantity of light bulbs in evaluated upstream lighting technologies by store type and program administrator, 2015 and 2017



Combined, SCE and SDG&E shipped over 5,000 light bulbs to more than 1,000 discount and grocery stores. SCE and SDG&E collectively shipped more than 10,000 discounted light bulbs to 171 different stores, *with some stores receiving up to 150,000 light bulbs at an individual store*. When reviewed against multiple data sources that give a very reliable estimate of statewide sales, these data reveal that the market could not have supported the volume of sales that the 2017 program data reported as shipped. The 2018 evaluations will further investigate what has been happening to unsold stock in discount and grocery stores in SCE and SDG&E service territories.

1.4 Results

[4] This discrepancy emerged after the 2017 evaluation workplan was completed.

1.4.1 Shipment versus sales quantity adjustment

We utilized multiple data sources to adjust the quantity of shipped light bulbs to the quantity of sold light bulbs.[5] This resulted in SCE receiving credit for 40% of the bulbs that were shipped, and SDG&E receiving credit for only 19% of the light bulbs that were shipped. This significantly reduced the amount of evaluated savings for SCE and SDG&E. Table 1-4 shows the sales quantity adjustments that we applied.

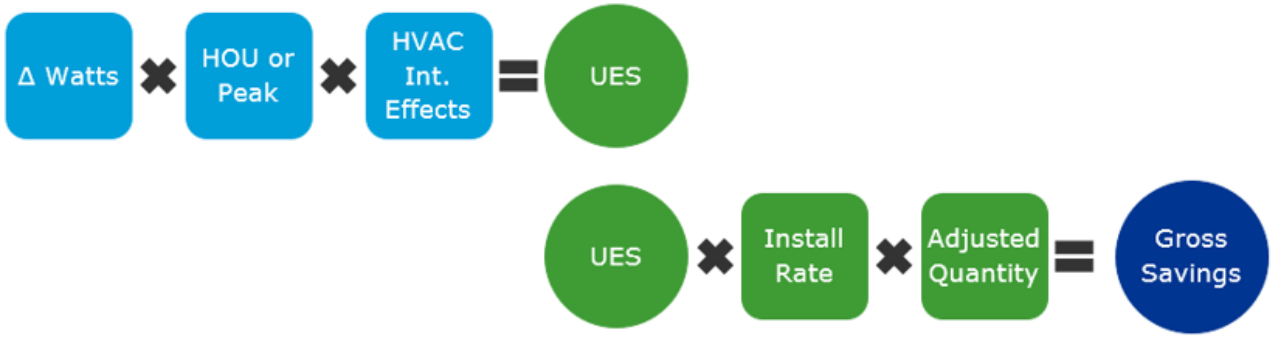
Table 1-4. Light bulb quantity adjustments by program administrator, 2017

Program Administrator and Channel	Light bulbs Shipped	Sales Quantity Adjustment	Light bulbs Credited
PG&E			
Discount	512,621	100%	512,621
Grocery	378,196	100%	378,196
Remaining Channels	1,476,566	100%	1,476,566
Total	**2,367,383**	**100%**	**2,367,383**
SCE			
Discount	4,093,491	33%	1,366,154
Grocery	6,854,708	13%	858,678
Remaining Channels	3,516,685	100%	3,516,685
Total	**14,464,883**	**40%**	**5,741,517**
SDG&E			
Discount	3,312,676	6%	211,837
Grocery	3,491,374	5%	157,771
Remaining Channels	1,097,727	100%	1,097,727
Total	**7,901,777**	**19%**	**1,467,336**

1.4.2 Gross savings results

The evaluation team calculated gross savings results for upstream technologies using the formula shown in Figure 1-2. We calculate the unit energy savings and then adjust quantities to calculate the gross savings.

Figure 1-2. Gross savings overview



[5] For more details please see section 4 of the main report.

Where:

- Delta Watts = The difference in wattage between the energy efficient light bulb and the light bulb being replaced
- HOU= Hours of use
- HVAC Int. Effects = HVAC interactive effects. LEDs and CFLs produce less heat than incandescent light bulbs, so their installation minorly increases heating loads.
- UES= Unit energy savings

Table 1-5 shows the gross realization rates[6] for the evaluated technologies in the upstream lighting program. A gross realization rate of 1.0 or 100% means the evaluated results were able to verify all the reported savings occurred. A realization rate greater than 1.0 or 100% indicates evaluated savings are higher than reported savings. This can occur if the evaluation revealed that alternative, non-program technologies were not as efficient as assumed in the reported savings estimates. PG&E did not have any major quantity adjustments with regard to sales versus shipments, contributing to the higher gross realization rate for PG&E. SCE and SDG&E technologies both see much lower gross realization rates as a direct result of the adjustments to quantity in the grocery and discount channels shown in Table 1-4.

Table 1-5. Gross kWh realization rates by evaluated upstream lighting technologies, 2017

Evaluated Measure Group	PG&E	SCE	SDG&E	Overall
CFL basic spiral ≤ 30 W	N/A	135%	N/A	135%
CFL high wattage (> 30 W)	155%	37%	9%	38%
LED A-lamp, all wattages	177%	78%	28%	69%
LED reflector, all wattages	180%	67%	25%	60%

1.4.3 Net savings results

The evaluation determined a net-to-gross ratio for each evaluated technology in the upstream lighting program. Table 1-6 shows the net-to-gross ratio for each evaluated technology and program administrator. LED reflectors and LED A-lamp light bulbs have net-to-gross ratios in the 64%-86% range, which indicate the program had a significant influence on customers' decisions to buy these light bulbs. CFL measures have lower net-to-gross ratios, indicating that more of these customers would have purchased this technology anyway.

[6] The gross realization rate is a comparison between predicted and actual gross energy savings.

Table 1-6. Net-to-gross ratios for all evaluated upstream lighting technologies by program administrator, 2017

Evaluated Measure Group	Evaluated Upstream Lighting Measure Group		
	PG&E	SCE	SDG&E
CFL basic spiral ≤ 30 W	N/A	17%	N/A
CFL high wattage (> 30 W)	17%	47%	31%
LED A-lamp, all wattages	86%	84%	64%
LED reflector, all wattages	81%	77%	71%

We applied these net-to-gross ratios to the gross savings to calculate the net savings for the program, or the savings that occurred as a direct result of the program. Table 1-7 shows the total reported and evaluated net savings by PA for GWh, MW and therms.

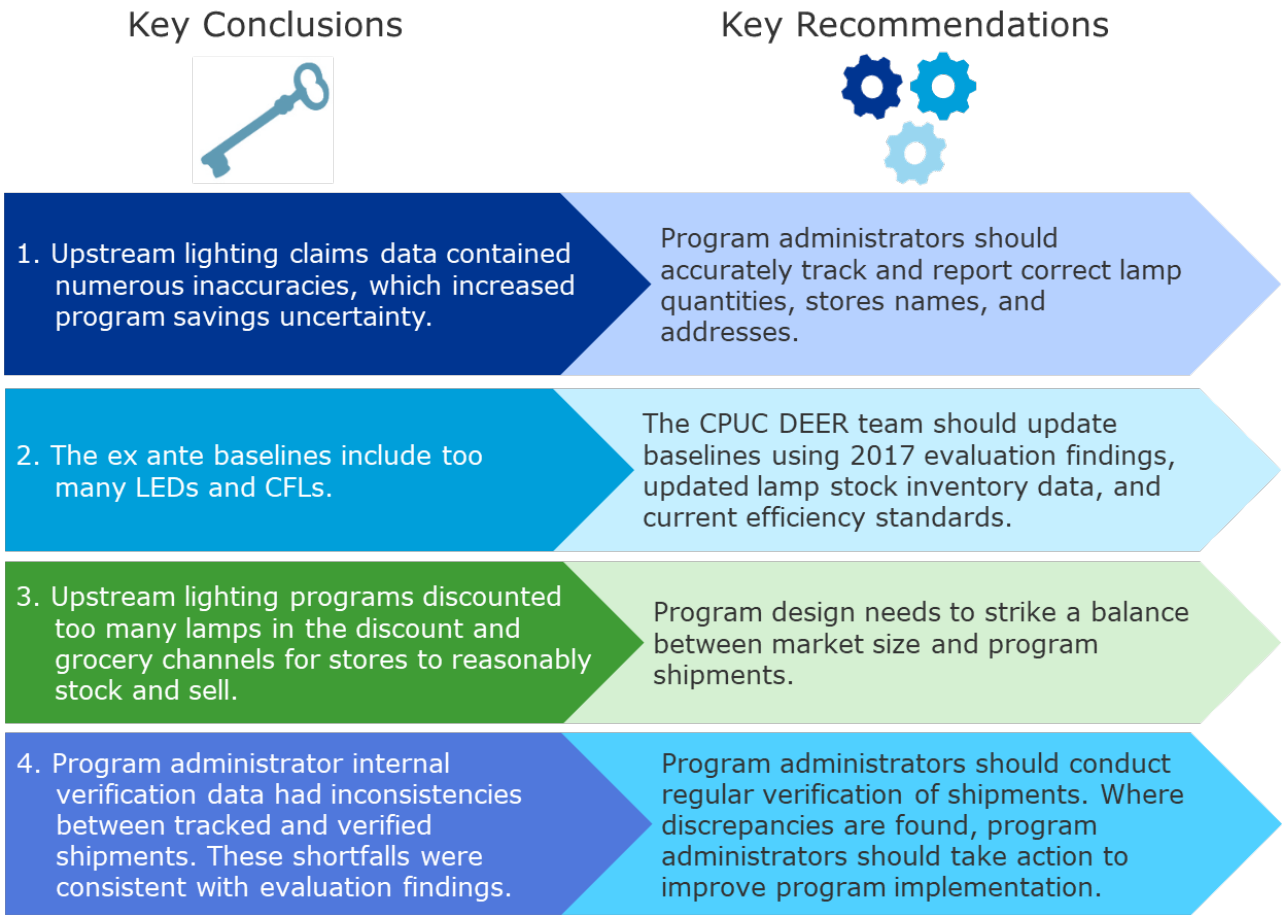
Table 1-7. Net savings for upstream lighting technologies by program administrator, 2017

PA	Ex Ante			Ex Post		
	GWh	MW	Million Therms	GWh	MW	Million Therms
PG&E	39	6	(1)	60	8	(1)
SCE	208	28	(3)	126	16	(2)
SDG&E	155	22	(2)	40	5	(1)
Total	**401**	**55**	**(6)**	**225**	**30**	**(4)**

1.5 Conclusions and Recommendations

Figure 1-3 provides a graphical summary of the evaluation's primary conclusions and recommendations. Detailed conclusions and recommendations are provided in Section 8.

Figure 1-3. Key conclusions and recommendations



2 INTRODUCTION

In this section, we provide an overview of the California lighting programs, detail the research objectives of the impact evaluation, provide an overview of the evaluation, and outline the organization of the report.

2.1 Program overview

Each California program administrator (PA)—including Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric Company (SDG&E)—implemented lighting programs designed to promote energy-efficient lighting across all market sectors during the 2017 program period. The scope of this evaluation focuses on residential lighting measures. The largest lighting program for each PA intended for the residential sector was the Primary Lighting Program. Primary lighting administered upstream incentives, meaning they provided discounts to manufacturers with the expectation that manufacturers and retail establishments will pass those discounts on to customers. While Primary Lighting is designed as a residential program, previous evaluations have found that around 6% to 7% of program lamps end up in non-residential sockets. We therefore include those non-residential measures as part of this evaluation.

In addition to primary lighting, there are an assortment of residential downstream programs. In these programs, residential customers directly received a rebate or the lamp itself. Downstream lighting programs make up a relatively small percentage of the program portfolio measure quantities and savings. Table 2-1 below displays the residential and non-residential quantity of lamps that each program discounted.

Table 2-1. Quantity of lamps discounted by program for all PAs, 2017

Program Type	Program Name	Residential / Non-Residential	Measure groups offered in Program – Quantity				
			LED A-lamps	LED reflector lamps	CFL basic spiral	CFL high wattage	Other
Upstream	Primary Lighting	Residential	7,889,619	11,561,084	4,709	3,789,168	1,123,045
		Non-Residential	505,740	741,560	180	241,983	73,402
Downstream	Mobile Home Direct Install	Residential	219,919	231	20	0	9,142
	Energy Upgrade California		0	0	0	0	81,285
	High Opportunity Program and Projects (HOPPS)		0	0	0	0	1,590
	Multifamily Energy Efficiency Rebate		419,627	41,636	0	0	244,918
	Direct Install		71,696	0	965	0	5,542
	Energy Fitness		94,405	15,259	0	0	0
	Government Partnerships		185,753	8,644	1,164	0	473,251

The upstream delivery mechanism has been a core part of the California PAs' compact fluorescent lamp (CFL) program activities for many years, but during the 2013-14 program period, the PAs began a shift away from CFLs and toward light-emitting diode (LED) lamps. Starting in January 2014, the California Public Utilities Commission's Energy Division (CPUC ED) required that the PAs demonstrate that the LED lamps that they incentivize meet the performance requirements outlined in the California Quality LED Specification developed by the California Energy Commission (CEC).[7] The requirements in the specification go beyond ENERGY STAR for lamp attributes such as color, dimmability, light distribution, and warranty, with the intent of meeting or exceeding customer expectations regarding lamp performance and light quality. The PAs began introducing LED lamps into the upstream program in relatively small quantities during 2013 and in ever increasing quantities from 2014 to 2017. Since 2015, the PAs have collectively reduced the number of CFLs that they provide incentives for each year.

The upstream and residential downstream lighting programs have changed since the previous evaluation of the 2015 programs, and it is worth recognizing how the 2017 programs total quantity of lamps and associated savings compare to 2015. As the ex ante baselines continued to get more efficient, PG&E slightly reduced the overall savings estimates of its upstream and residential downstream lighting programs and slightly increased its lamp quantities (see Table 2-2). SCE reduced its overall savings estimates but had a notable increase in the number of lamps it discounted to achieve those savings. SDG&E implemented the most dramatic change. SDG&E increased their upstream and residential downstream portfolio roughly five-fold and estimated that these programs achieved 155 GWh net savings in 2017, compared to an estimated 33 GWh net savings in 2015. To achieve these savings, they discounted more than four times as many lamps in 2017 compared to 2015.

Table 2-2. Summary of PA-reported ex ante net annual energy savings and quantity of discounted lamps from upstream and residential downstream lighting measures, 2015 and 2017

Program Year	PA Reported Net Energy Savings (GWh)				Quantity of Lamps			
	PG&E	SCE	SDG&E	Total	PG&E	SCE	SDG&E	Total
2015	44	212	33	**288**	3,440,260	10,258,827	2,019,998	**15,719,085**
2017	39	208	155	**401**	3,951,597	15,153,891	8,700,049	**27,805,537**

As the LED market continues to mature, efficient lamps have become more cost effective and more popular, and it has become more difficult for upstream lighting programs to achieve the same overall magnitudes of savings. Our evaluation investigates the impacts of these changes at the retail channel level.

2.2 Analysis of measure uncertainty

The uncertain measure list[8] presents an analysis that estimates the areas of greatest savings uncertainty within California's Energy Efficiency portfolio. This list serves as guidance for evaluators to consider when they develop their evaluation work plans. It is important for regulators, program staff, and evaluators to understand why measures are on the uncertain measure list and what keeps measure on the uncertain measures list. Measure level uncertainty contributes to overall portfolio uncertainty, so it is important for evaluations to reduce that uncertainty moving forward.

[7] CEC 2017.

[8] CPUC 2016.

The bulk of 2017 residential lighting claims were administered through the Primary Lighting program, we considered measures on the uncertain measure list as upstream measures and passed-through all downstream savings. The 2017 uncertain measure list included two of the four measure groups that we researched in this evaluation: indoor LED lamps (A-lamps) and indoor LED reflectors. Although the uncertain measure list also included indoor LED fixtures and outdoor LED fixtures, we did not evaluate these measure groups due to their relatively small contribution to the overall portfolio. In addition to the measures on the uncertain measure list, our review of updated tracking data revealed the need to also research high wattage CFLs. Lastly, as we perform our savings methodologies on lamp-replacement categories, we consider basic CFLs as an evaluated measure as well because customers can use basic CFLs and LED A-lamps interchangeably in many applications.

We designed the primary research questions and methodologies of this evaluation to reduce the uncertainty of gross baselines and net-to-gross ratios, both of which the uncertain measure list classified as uncertain. The current ex ante assumptions for gross baselines and net-to-gross ratios were developed in the 2017 disposition and not from an evaluation. Therefore, they do not have the same quantitative methodological rigor as the results in this evaluation. The impact evaluation results will be applied to future ex ante planning assumptions to reduce future uncertainty around these parameters. It is important to recognize that lighting baselines are continuing to change rapidly. Therefore, even as we reduce savings uncertainty this year, the savings will again be uncertain next year due to new market changes. Table 2-3, below, lists the measures that the 2015 and 2017 uncertain measure lists and the 2015 and 2017 impact evaluations included.

Table 2-3. 2017 uncertain measure list measures included in impact evaluation

Measures	Uncertain Measure List		Evaluation		Factors Driving Uncertainty in 2017
	2015	2017	2015	2017	
Indoor high wattage CFLs	X		X	X	Large portion of portfolio savings; baseline mix assumptions, installation rates, and sell-through rates
Indoor LED Lamp	X	X	X	X	Large portion of portfolio savings; baseline mix assumptions, installation rates, and sell-through rates
Indoor LED Reflector		X	X	X	Large portion of portfolio savings; baseline mix assumptions, installation rates, and sell-through rates
Basic CFLs	X		X	X	Low uncertainty in 2017
CFL Reflectors			X		Low uncertainty in 2017
CFL A-lamps			X		Low uncertainty in 2017

The number of uncertain measures and parameters that the uncertain measure list has identified has continued to decrease since the inception of the rolling portfolio. Selecting measures to include in the uncertain measure list depends on the uncertainties among the parameters within savings calculations as well as the quantities of each measure group that the program discounted. For example, as lighting measures have moved away from CFLs and towards LEDs, the uncertain measure list has dropped CFLs. This is in part because measure level uncertainty has been reduced, and also because their portion of portfolio-level savings was reduced as programs moved towards LEDs. Additionally, prior upstream lighting

evaluations have invested research efforts to reduce the uncertainty of hours-of-use, installation rates, and baseline estimates.

The evaluation results of this report will reduce the uncertainty of 2017 gross and net savings relative to their ex ante estimates. We expect that the 2018 uncertain measure list will include LED reflector lamps, as 2018 CEDARS tracking data shows these measures made up the bulk of upstream savings claims.[9] We expect that the savings uncertainty will remain for LED measures due to their upstream sell through rates, as well as changes in market baselines and NTGRs. In this evaluation, we found that the upstream programs have focused more heavily on discount and grocery stores than in previous years. Uncertainty for sell through rates will continue until further research is conducted to understand this issue; from future evaluations as well as tracked verification from program administrators. We also recommend revisiting the residential/non-residential assumptions as part of the 2018 evaluation scope.

2.3 Research objectives

The primary objective of this impact evaluation is to verify and validate the PAs' reported energy savings and peak demand reduction estimates. Our approach has three goals:

1. Develop measure quantity adjustments, which we derive from program invoice and application verification, an assessment of the percentage of discounted products purchased by non-California Investor-Owned Utility (PA) customers (i.e., leakage), and an assessment of the percentage of discounted products purchased by residential versus non-residential customers. As part of the 2017 evaluation, we also added a sales-to-shipment ratio to adjust the quantity of program lamps so that they reflect the estimated quantity of lamps that the participating retailers actually sold.
2. Develop gross savings inputs, which include an assessment of the percentage of discounted measures installed as well as estimates of the average daily hours-of-use (HOU), the average percent of measures operating at peak coincidence factor (CF), the difference between the program lamp wattage and the wattage displaced by PA-discounted measures (delta watts), unit energy savings (UES) in kWh/year and peak kW, and installation rate. As part of the 2017 evaluation, we updated the gross savings baseline wattage in the delta watts calculation to reflect the wattage of non-program technologies that would be sold naturally in the market (as opposed to using the wattage installed in homes as the baseline wattage).
3. Develop net savings inputs, which include estimates of the NTGR.

To accomplish the goals mentioned above, this evaluation addresses 6 specific research questions.

1. **What is the average wattage of lamps displaced by upstream program lamps?** We answer this research question by using a market-based approach to estimate technology sales shares both with and without program discounts in place and quantify the difference in energy consumption between the two scenarios. The baseline is a key component to calculating the delta watts parameter. We discuss this methodology and present calculated LED baselines in Section 5 (Gross Savings Methodology).
2. **What is the appropriate baseline for residential upstream CFLs?** We answer this research question to quantify the average wattage that program CFLs displace in the market. The baseline is a key component to calculating the delta watts parameter. We discuss this methodology and present calculated CFL baselines in Section 5 (Gross Savings Methodology).

[9] 2018 Record-Level Claims Report downloaded 02/22/2018. https://cedars.sound-data.com/reports/record-level/

3. **What are the ex post savings results for evaluated measures?** This research question is the thrust of this evaluation. We present our ex post savings research methodologies in in in Section 5 (Gross Savings Methodology) and Section 6 (Net Savings Methodology), and present lighting program savings estimates in Section 7 (Study Results).
4. **What is the free-ridership level for residential upstream LED A-lamps, LED reflectors, high wattage CFLs and basic CFLs?**
5. **What are the annual sales of lamps in grocery and discount stores?** We added this research question after we began observing unexpectedly large quantities of LED lamps shipped to grocery and discount stores. We looked at multiple sources of data to estimate low and high bounds of the annual lamp sales in grocery and discount stores. We present this methodology and related findings in Section 4.1 (Sales-to-Shipment Ratios)
6. **After verifying program lamp shipment quantities in grocery and discount stores and estimating annual lamp sales in these channels, what are the lamps sales-to-shipment ratios in grocery and discount stores?** Once we estimated the grocery and discount store lighting market potential sales volumes, we determined it was necessary to reduce the number of program lamps that programs shipped to quantities that were actually sold. We developed the sales-to-shipment ratio to answer this research question and present this methodology and related findings in Section 4.1 (Sales-to-shipment ratios).

2.4 Evaluation overview

We designed this impact evaluation to address all lighting measures associated with the upstream delivery mechanism as well as all downstream lighting measures targeted at the residential sector by PG&E, SCE, and SDG&E. Upstream and residential downstream lighting measures accounted for 3% to 35% of each PA's ex ante net annual electric savings and 2% to 27% of each PA's net peak demand reductions (see Table 2-5). During the 2015 program period,[10] upstream and residential downstream lighting measures accounted for 4% to 18% of each PA's reported net energy savings and 2% to 11% of each PA's reported net peak demand impacts.

Table 2-4. Summary of PA-reported ex ante net annual savings from upstream and residential downstream lighting measures, 2017

PA	PA Reported Net Annual Savings					
	Total Portfolio		Upstream / Residential Downstream Lighting		Upstream / Residential Downstream Lighting as Percent of Total Portfolio	
	Energy (GWh)	Peak Demand Reduction (MW)	Energy (GWh)	Peak Demand Reduction (MW)	Energy (GWh)	Peak Demand Reduction (MW)
PG&E	1,340	291	39	6	3%	2%
SCE	1,364	254	208	28	15%	11%
SDG&E	440	80	155	22	35%	27%
Statewide	**3,143**	**625**	**401**	**55**	**13%**	**9%**

Ex ante data used in this table and throughout the report were final as of October 15, 2018.

[10] There was no evaluation of the 2016 upstream and residential downstream lighting programs.

Upstream lighting measures comprised the vast majority of the combined total upstream and residential downstream lighting measures during the 2017 program period (Table 2-5). As such, the remainder of this report focuses on upstream lighting measures, and in particular, the measures identified as part of the Energy Savings Performance Incentive (ESPI) uncertain measure list[11] that account for the majority of ex ante savings within the upstream program. For residential downstream measures and for all upstream measures not included in the four evaluated upstream lighting measure groups described below, we are passing through the ex ante estimates for energy savings (kWh), demand reductions (kW), and gas impacts (therms).[12]

Table 2-5. Summary of PA-reported ex ante upstream and residential downstream lighting measure savings for evaluated and passed-through measure groups, 2017

PA/Lighting Measure Category	Ex Ante Upstream and Residential Downstream Lighting Gross Savings					
	Energy		Demand		Gas Impacts	
	GWh	% of GWh	MW	% of MW	Million Terms	% of Therms
PG&E						
Upstream - evaluated	36.6	74%	5.3	75%	-0.7	74%
Upstream - passed through	10.2	21%	1.5	21%	-0.2	21%
Downstream - passed through	2.7	5%	0.3	4%	0.0	5%
Subtotal – PG&E	**49.5**	**100%**	**7.1**	**100%**	**-0.9**	**100%**
SCE						
Upstream - evaluated	238.3	91%	33.8	98%	-3.9	97%
Upstream - passed through	0.0	0%	0.0	0%	0.0	0%
Downstream - passed through	22.4	9%	0.7	2%	-0.1	3%
Subtotal – SCE	**260.7**	**100%**	**34.5**	**100%**	**-4.0**	**100%**
SDG&E						
Upstream - evaluated	151.6	87%	21.5	89%	-2.0	90%
Upstream - passed through	14.2	8%	2.1	9%	-0.2	8%
Downstream - passed through	8.3	5%	0.4	2%	0.0	2%
Subtotal – SDG&E	**174.1**	**100%**	**24.1**	**100%**	**-2.2**	**100%**
All PAs						
Upstream – evaluated	426.5	88%	60.6	92%	-6.5	92%
Upstream - passed through	24.4	5%	3.6	6%	-0.4	5%
Downstream - passed through	33.4	7%	1.4	2%	-0.2	3%
Grand Total – All PAs	**484.3**	**100%**	**65.7**	**100%**	**-7.1**	**100%**

[11] CPUC 2016.

[12] For these "pass through" measures, all ex ante assumptions and inputs are passed through as ex post.

Upstream lighting measures fall into 5 groups, each of which consists of similar measures. For example, the LED reflector measure group includes all LED reflector lamp wattages and styles, such as parabolic aluminized reflector (PAR) and multifaceted reflector (MR) lamps. While savings claims included within the PA tracking data are based on assumptions tied to specific measure characteristics, the evaluation applies updates to savings at the measure group level. The five measure groups are:

- LED A-lamps of all wattages
- LED reflector lamps of all wattages
- LED fixtures of all wattages
- CFL basic spiral ⩽ 30 watts
- CFL high wattage (> 30 watts)

This evaluation focuses on four of the five upstream lighting measure groups. Taken together, these measures account for 88% of the PAs' ex ante net savings (as shown in Table 2-5 above).

The 2017 evaluation addresses two upstream measure groups for light-emitting diode (LED) lamps and two measure groups for compact fluorescent lamps (CFL)[13]:

- LED A-lamps of all wattages
- LED reflector lamps of all wattages
- CFL basic spiral ⩽ 30 Watts
- CFL high wattage (> 30 Watts)

The two evaluated CFL measures were the only CFL measures that received upstream incentives from the PAs in 2017. We did not evaluate the LED fixtures measure group because they only accounted for less than 10% of the portfolio.

Table 2-6 shows the quantity of lamps shipped in 2017 by evaluated lighting measure group and PA. As shown, the combined total of lamps shipped for the 3 PAs was nearly 25 million. This is an 82% increase from the 2015 program cycle when the 3 PAs shipped approximately 13.6 million lamps. While the total number of lamps shipped by PG&E declined by 11% from approximately 2.7 million lamps in 2015 to 2.4 million lamps in 2017, the volume of lamps shipped by SDG&E increased nearly five-fold from approximately 1.6 million lamps in 2015 to 7.9 million lamps in 2017. SCE increased the number of lamps it shipped in 2017 by 56% comparted to 2015 (from approximately 9.3 million lamps to 14.5 million lamps). Overall, LED lamps comprised 84% of lamps shipped in 2017 while CFLs comprised only 16% of lamps. LED reflectors comprised a majority of lamps (50%) across the PAs and accounted for the largest share of lamps shipped within each PA. Taken together, LED reflectors and A-lamps represented 97% of all lamps shipped for both PG&E and SDG&E and 74% of lamps for SCE. High wattage CFLs accounted for more than a quarter of the lamps that SCE shipped in 2017 compared to only 3% of the lamps that PG&E and SDG&E shipped.

[13] These two CFL measures were the only CFL measures that PAs discounted in 2017.

Table 2-6. Quantity of lamps by evaluated upstream lighting measure group and PA, 2017

Evaluated Upstream Lighting Measure Group	Quantity (Number of Lamps)			Overall Quantity (Across PAs)	
	PG&E	SCE	SDG&E	Total	% of Total
CFL basic spiral ≤ 30 W	0	4,889	0	4,889	0%
CFL high wattage (> 30 W)	81,000	3,697,743	252,408	4,031,151	16%
LED A-lamp, all wattages	887,750	4,331,310	3,176,299	8,395,359	34%
LED reflector, all wattages	1,398,633	6,430,941	4,473,070	12,302,644	50%
Overall	**2,367,383**	**14,464,883**	**7,901,777**	**24,734,044**	**100%**

Table 2-7 lists the PA-reported portfolio-level net annual energy savings by evaluated upstream lighting measure for residential and non-residential programs. As shown, LED reflector lamps accounted for nearly 60% of portfolio-level net annual energy savings across the 3 PAs, while LED A-lamps and high wattage CFLs accounted for 16% of net savings each. LED reflectors comprised 59% of PG&E's net annual energy savings followed by LED A-lamps at 16%. Similarly, LED reflectors comprised 68% of SDG&E's net savings while LED A-lamps comprised 19% of savings. While LED reflectors comprised 50% of SCE's net savings, high wattage CFLs accounted for the second largest amount of net savings at 28%.

Table 2-7. Reported portfolio-level ex ante net annual energy savings by upstream lighting measure group for residential and non-residential measures, 2017

Evaluated Upstream Lighting Measure Group	Ex Ante Net Annual Energy Savings (kWh)			
	PG&E	SCE	SDG&E	Overall
CFL basic spiral ≤ 30 W	0	62,562	0	62,562
CFL high wattage (> 30 W)	1,656,316	57,583,032	5,358,702	64,598,050
LED A-lamp, all wattages	6,046,592	29,087,525	29,309,998	64,444,115
LED reflector, all wattages	22,586,683	104,217,264	105,696,158	232,500,105
Pass-through lighting measures	8,250,036	16,792,633	14,292,806	39,335,475
Overall	**38,539,627**	**207,743,016**	**154,657,664**	**400,940,307**

Table 2-8 lists the PA-reported portfolio-level peak demand reductions by evaluated upstream lighting measure for residential and non-residential programs. Overall, LED reflectors accounted for 61% of net annual peak demand reductions, followed by LED A-lamps (17%) and high wattage CFLs (16%). LED reflectors comprised 59% of PG&E's, 55% of SCE's, and 69% of SDG&E's net peak demand reductions. LED A-lamps comprised the second largest net peak demand reduction among the evaluated measures for PG&E (16%) and SDG&E (19%), while high wattage CFLs comprised the second largest net peak reduction for SCE (28%).

Table 2-8. Reported portfolio-level ex ante net annual peak demand reductions by upstream lighting measure group for residential and non-residential measures, 2017

Evaluated Upstream Lighting Measure Group	Ex Ante Net Peak Demand Reductions (MW)			
	PG&E	SCE	SDG&E	Overall
CFL basic spiral ≤ 30 W	0	9	0	9
CFL high wattage (> 30 W)	245	7,714	783	8,742
LED A-lamp, all wattages	880	4,170	4,153	9,203
LED reflector, all wattages	3,281	15,401	14,952	33,634
Pass-through lighting measures	1,148	529	1,637	3,313
Overall	**5,553**	**27,823**	**21,524**	**54,901**

2.5 Report overview

We have organized the remainder of this report as follows:

- Section 3 describes the study's data sources and provides an overview of the Lamp Choice Model.
- Section 4 describes our approach to measure quantity adjustment.
- Section 5 gives an overview of the gross savings methodology and results with examples.
- Section 6 gives an overview of net savings methodology and results with examples as well as the net-to-gross ratios.
- Section 7 provides evaluated gross savings results and net savings results by PA.
- Section 8 includes the evaluation's conclusions and recommendations.
- Section 9 includes a list of references.
- Appendix A provides the ex ante and ex post first year and lifecycle savings tables per the CPUC ED Impact Evaluation Standard Reporting (IESR) Guidelines.[14]
- Appendix B provides the ex post first year, annual, and lifecycle savings and effective useful life (EUL) per the CPUC ED IESR Guidelines.
- Appendix C provides standardized recommendations per the CPUC ED IESR Guidelines.
- Appendix D provides waterfall graphics that demonstrate the energy savings changes relative to each parameter.
- Appendix E includes the data collection instruments used to support the evaluation.
- Appendix F describes the methodology used in the Lamp Choice Model methodology.
- Appendix G provides additional gross and net savings tables.
- Appendix H describes the approach for compiling CREED lamp sales data and provides additional sales data tables.
- Appendix I provides tables on the results of the lighting retail store telephone survey.
- Appendix J includes a table of public comments on the draft version of this report that was posted March 1, 2019 and responses to those comments.

[14] CPUC ED 2015a.

3 DATA SOURCES

In this section, we provide an overview of the data sources used for the evaluation and a description of the Lamp Choice Model.

The 2017 impact evaluation relied upon several data sources. These sources and their corresponding research questions (described in section 2.3) are provided in Table 3-1 on the next page. We provide more details on these sources in the remainder of this section.

Table 3-1. Research questions and associated data sources, 2017

Research Question	Data Source							
	Program Tracking Data	Lamp Choice Model	Consumer surveys	Supplier Interviews	Retail Store Manager Surveys	Retail Lamp Stock Inventories	Shopper Intercept Surveys	CREED Light-Tracker Sales Data
1. What is the appropriate baseline for residential upstream LED lamps?	X	X	X	X		X	X	
2. What is the appropriate baseline for residential upstream CFLs?	X	X	X	X		X	X	
3. What are the ex post savings for evaluated measures?	X	X	X	X		X	X	
4. What is the free-ridership level for residential upstream LED lamps?		X	X	X			X	
5. What is the free-ridership level for residential upstream CFLs?		X	X	X			X	
6. What are the annual sales of lamps and sales-to-shipment ratios in grocery and discount stores?	X	X	X	X	X			X

3.1 Program tracking data

Each of the PAs uploads program tracking data onto a centralized server. We downloaded these data and then analyzed, cleaned, re-categorized, reformatted, and merged these separate datasets into one program tracking database. The tracking data provide details regarding the quantity of lighting measures shipped as well as details regarding the manufacturers and retailers involved in the 2017 upstream lighting program. The tracking data also enables us to produce estimates of the average discounted lamp wattage for each evaluated upstream lighting measure group and PA and provides the ex-ante values needed to pass through for specific parameters that we did not address in this evaluation. We provide more discussion regarding the program tracking data in the measure quantity adjustments (Section 4.1) and gross savings analyses (Section 7.1).

3.1.1 Program tracking data issues

The evaluation team encountered data quality issues with the program tracking data during the course of the 2017 impact evaluation, including:

- Missing or inaccurate store name
  - The data requests either failed to provided store names or provided store names that were not associated with the provided address.
- Incomplete or inaccurate retail store addresses
  - Many addresses were missing full address information, such as suite number. In other cases, locations had multiple, but adjacent, addresses for one store name.
- Inaccurate shipment quantities
  - Many stores had an average quantity of shipments across multiple stores. For example, a shipment of 4,000 lamps would be split evenly for a given chain into shipments of 800 across five store fronts.

3.2 Lighting sales data

Apex Analytics provided DNV GL with 2017 retail replacement lightbulb sales data in California from the Consortium of Retail Energy Efficiency Data (CREED). The sales data included point of sales (POS) data for select retailers from discount, drug, grocery, mass merchandise, and select membership club stores sales channels. The data also included a panel estimate of the remaining sales across the California market, this includes home improvement, hardware, remaining stores from the POS channels, and online stores. The POS data was also further broken out into three metro areas: Los Angeles, San Francisco, and Sacramento. Apex Analytics processed and analyzed the POS and non-POS panel data into tables that were broken out by lighting technology (CFL, LED, halogen, incandescent) and additional granularity for CFL (by wattage) and LED (by lamp shape). See Appendix G for a full memo describing the CREED sales data and associated 2017 sales data tables.

3.3 Lighting retail store telephone surveys

From late January to early February 2019, the evaluation team conducted telephone surveys with grocery and discount stores in SCE and SDG&E service territories that received shipments of PA-discounted lamps in 2017. The primary research objective of the telephone surveys was to obtain an estimate of lighting sales

volume in these stores in each service territory. The secondary research objective of the surveys was to better understand what these stores do with any unsold PA-discounted lamps. The team's sampling expert divided the grocery and discount stores that received 2017 PA-discounted lamps in 2017 into 8 strata, which included combinations of independent and chain grocery and discount stores in each service territory. As shown in Table 3-2, the team targeted 75 completed surveys and ultimately completed 83 surveys. The sample design was created with a targeted 90/10 precision on sales estimates, using the shipments as proxy. However, the sales estimates ended up differing from the shipments more than expected, including 20 stores that responded they did not sell light bulbs and had not sold any in the last 3 years. We show results and standard errors in Section 4.1.5.

Table 3-2. Final disposition of 2019 lighting retail store telephone surveys

PA	Channel	Target	No Lamp Sales (in last 3 years)	Sell or Have Sold Lamps and Provided Sales Estimate	Total Complete
SCE	Chain Discount	13	1	13	14
SCE	Chain Grocery	6	5	4	9
SCE	Independent Discount	6	2	3	5
SCE	Independent Grocery	6	3	3	6
SDG&E	Chain Discount	10	1	14	15
SDG&E	Chain Grocery	6	1	4	5
SDG&E	Independent Discount	11	1	10	11
SDG&E	Independent Grocery	17	6	12	18
Total		**75**	**20**	**63**	**83**

3.4 Consumer surveys

During October 2016, DNV GL conducted telephone surveys with PG&E, SCE, and SDG&E residential electric customers in support of the 2015 impact evaluation. These surveys asked consumers how many lamps they purchased within the A-lamp and reflector lamp replacement categories since January 1, 2015, and where they made those purchases. The 2016 consumer telephone survey addressed several key inputs to the 2015 upstream and residential downstream lighting program impact evaluation, including:

1. Installation rates
2. Satisfaction with LED lamps
3. Inputs into the lamp choice model
4. Insights into channel shift

In addition to the telephone surveys, the evaluation team implemented online surveys during the fourth quarter of 2016 and completed 316 online surveys with high wattage CFL purchasers. The primary purpose of the 2016 online surveys was to identify the baseline technology mix and wattage for high wattage CFLs. As with the consumer telephone surveys, only electric customers of PG&E, SCE, or SDG&E were eligible to

complete the online survey. For a more detailed overview of the 2016 consumer telephone surveys and online surveys, see Section 3.1 of the 2015 impact evaluation.[15]

3.5 Lamp supplier in-depth interviews

DNV GL staff conducted in-depth telephone interviews with lamp supplier representatives during the fourth quarter of 2016. Individual respondents included representatives of lamp manufacturing organizations and buyers from national brick-and-mortar retail chains. The sample frame included 17 manufacturing organizations that shipped discounted lamps in evaluated upstream lighting measure groups through the 2015 program. The frame also included the 3 retail chains that sold the most lamps discounted by these manufacturers, as well as 3 smaller retail chains that sold program-discounted lamps. In addition to suppliers who participated in the 2015 upstream lighting program, the team also attempted to interview non-participants to obtain a more complete picture of California's retail market for replacement lamps. Individual manufacturers often represent larger shares of the overall replacement lamp market than individual retailers because they often serve multiple retain chains, so the team focused interviewing efforts on manufacturers' representatives.

Our supplier interviews addressed the following topics:

- Inputs to the lamp choice model
- Insights into channel shift
- LED lamps that do and do not meet the California Voluntary Quality LED Lamp Specification (CEC spec).

In addition to these three topics, we also developed and tested a methodology to address free-ridership in the 2015 upstream lighting program via the supplier interviews. For a more detailed overview of the 2016 consumer telephone surveys and online surveys, see Section 3.2 of the 2015 impact evaluation.[16]

3.6 Retail lamp stocking inventories and shopper intercept surveys

The evaluation team conducted detailed inventories of lamps for sale in California retail stores throughout PG&E, SCE and SDG&E service territories in support of the 2015 impact evaluation and prior evaluation periods. During the shelf inventories, we conducted intercept surveys with consumers who were shopping for lamps. The stock inventories gathered information regarding all residential replacement lamps stocked in the stores other than linear fluorescent lamps. The shopper intercept surveys focused on shopper purchasing decisions and installation intentions for the newly-purchased lamps.

The team completed the most recent phase of stock inventories and shopper intercept surveys during the winter of 2015-16 and is conducting stock inventories in support of the program year 2018 impact evaluation that will be completed in the first quarter of 2019. Field staff spent a minimum of four hours in each store completing the shelf surveys and attempting to intercept shoppers. Field staff completed surveys opportunistically—that is, with individuals who were shopping during the time periods in which we conducted intercept surveys in specific stores. As such, results from the intercept surveys may not represent the broader population of shoppers purchasing replacement lamps at various stores throughout the year.

[15] DNV GL 2017b.
[16] Ibid.

Nonetheless, given the range in timeframes and store types in which we conducted these surveys, results provide general indications of shopper preferences, price sensitivity, lamp installation intentions, and so on.

The lamp stock inventory sample targeted approximately 200 stores. We stratified the sample by retail channel and IOU service territory (for PG&E, SCE, and SDG&E territories) and designed the sample to represent the retail market for residential replacement lamps in these areas. The sample design targeted roughly equal numbers of stores in each retail channel to ensure enough sample points per channel to enable channel-to-channel comparisons.

To support the 2015 impact evaluation, the evaluation team leveraged the retail lamp stock inventory results primarily to support the Lamp Choice Model. The lamp choice reflects the lamp prices and availability that field staff observed in retail stores during the retail stock inventories. We updated the Lamp Choice Model to ensure that it represents the mix of lamp stock found on retail shelves during the winter of 2015-16. For a more detailed overview of the lamp stock inventories and shopper intercepts surveys, see Appendix B of the 2015 impact evaluation.[17]

3.7 Prior EM&V studies

We relied upon data from other EM&V studies to support the overall evaluation efforts that we describe herein. These data sources include:

- Impact Evaluation of 2015 California Upstream and Residential Downstream Lighting Programs (DNV GL, 2017). This study included all lighting measures associated with upstream delivery mechanisms and all downstream lighting measures targeted at the residential sector. The impact evaluation focused on six measures that collectively accounted for over 87% percent of the PAs' ex ante net savings from upstream and residential downstream measures. These measures included basic spiral CFLs, CFL A-lamps, CFL reflectors, high wattage CFLs (>30 watts) LED A-lamps, and LED reflectors. Several of the impact evaluation parameters and methodologies used in the 2015 program cycle were "passed through" and utilized in the current evaluation. We also conducted the 2016 consumer telephone surveys in support of the 2015 evaluation and the 2017 evaluation; we describe our use of these results in Section 3.4 above.
- California Lighting and Appliance Saturation Study (DNV GL, 2014a). The California Lighting and Appliance Saturation Study (CLASS) updates and augments saturation and efficiency characteristics from previous CLASS studies conducted in 2005 and 2000 for use in understanding future energy savings potential and past accomplishments in the residential sector. The 2012 CLASS included onsite observations on a sample of 1,987 single-family, multi-family and mobile home residences with individually-metered electric accounts across the service territories of PG&E, SCE and SDG&E. The program year 2017 impact evaluation relied upon CLASS data to update the delta watts, HOU, and peak coincidence factors for CFLs and LED lamps. We provide more detail in Section 5 (Gross Savings).
- Residential Lamp Inventory and Metering Study (DNV GL, 2014c). We conducted detailed lamp inventories and hours-of-use metering of lamps in more than 2,000 California households as part of the California Upstream and Residential Lighting Impact Evaluation Work Order 28 (WO28) Final Report. In this evaluation, we apply these saturation data to metering data collected in support of the 2006-2008 evaluation to support estimates of average daily hours of use and peak coincidence factor. Please refer to our gross savings analyses in Section 5 for further detail.

[17] Ibid.

- 2016 Hedonic Pricing Model (DNV GL, 2016b). As part of 2010-12 Evaluation, EM&V Work Order 17 (Measure Cost study[18]), the DNV GL team created a hedonic pricing model for four LED lamp styles including A-lamp, reflector, globe, and torpedo. Hedonic pricing models are regression models that predict price as a function of several variables. We used this model to estimate full-retail program lamp price in our LCM simulations, if the program lamp was not observed during our retail lamp stock inventory data collection.

3.8 Lamp Choice Model

The DNV GL team developed a residential consumer Lamp Choice Model as part of the impact evaluation of the PAs' 2010-12 upstream and residential downstream lighting programs to quantify consumer responses to upstream lighting incentives.[19] The model relies upon data from the retail lamp stock inventories and in-store shopper intercept surveys to predict the probability that a consumer will choose a particular lamp. The intercept surveys collected information on consumer choices required for the model, while the shelf surveys captured information regarding the context for those choices, including details related to the selected lamp, its intended application, the retail channel in which the lamp was selected, and characteristics of the lamp purchaser. The Lamp Choice Model uses a nested logit model structure to predict consumer choices over a set of discrete alternatives.

Key model features include:

- **Market share predictions.** The model predicts changes in market shares as a response to price changes such as those that incentive programs introduce.
- **Heterogeneous price sensitivities.** Not all consumers have the same price sensitivity. The model design reflects that price sensitivities vary by consumer household income and whether the consumer is making an impulse or planned purchase.
- **Retail channel differences.** The model design recognizes that consumers have price sensitivities and choice sets that vary by retail channel. Specifically, the channels examined in the current study are: discount stores, drug stores, grocery chain stores, grocery independent stores, hardware stores, home improvement stores, mass merchandise stores and membership club stores.

For the 2017 impact evaluation, our approach to using the Lamp Choice Model was as follows:

1. **Leverage the 2015 Lamp Choice Model estimation.** We re-estimated the Lamp Choice Model with new shopper intercept survey data from winter 2015-16 as part of the 2015 Upstream and Residential Downstream Lighting Evaluation. Since this iteration of the model includes data as recent as 2016, in this evaluation, we use the 2015 Upstream and Residential Downstream Impact Evaluation model estimation.
2. **Estimate market shares under two scenarios by channel.** We estimated market shares using a simulation-based approach. The simulation involves two inputs. The first input is a representation of consumers based on results from the 2016 consumer telephone survey representing the retail channels in which shoppers typically purchase lamps of various types and the demographics of those shoppers. Unlike the shopper intercept survey data, the consumer telephone survey data are a representative

[18] Itron and DNV GL 2014.
[19] DNV GL 2014c.

sample of consumers in the lamp market. The second input is a representation of available lamp choices based on retail lamp stock inventory data. We ran the simulation against two scenarios:

- **With program scenario.** This scenario reflects the lamp prices and availability that DNV GL observed in retail stores during the retail lamp stock inventories conducted in winter 2015-16. This scenario results in an estimate of the share of program lamp sales for each modeled technology in 2016. While these data may be slightly less efficient than the actual stock would have appeared in 2017, Title 20 code, which mandated ramped up retail lamp efficacy standards, would have shifted the retail-stock wattages substantially lower in 2018, when this evaluation could have collected these data.[20] We therefore consider the 2016 data a more accurate reflection of 2017 conditions that 2018 would have been.
- **Without program scenario.** This scenario reflects the lamp prices as well as stocking changes that consumers would have seen in California retail stores in 2017, if the program had not occurred. DNV GL estimated price differences based on matching lamps to program tracking data. This scenario results in a counterfactual estimate of market shares that would have occurred if only prices on program-discounted lamps changed due no program activity. As we described in Section 3.5 above, we asked supplier representatives to indicate whether their companies would or would not have sold specific lamp types through specific retail channels in the absence of the program, and we considered those lamps to be program-reliant. For example, if a supplier representative told us he or she would not have sold basic spiral CFLs to drug stores without upstream lighting program incentives, we considered the presence of these lamps in drug stores to be program-reliant. In a select number of cases, we use supplier responses to account for additional program influences (see the Simulation and Scenario Analysis Methodology in Appendix F). This scenario resulted in a counterfactual estimate of market shares if program-reliant lamps were not in stores and if the PAs did not discount lamps.

The Lamp Choice Model calculates the probability that a given customer would chose each lamp technology and shape, when program-discounted lamps were available. The model necessarily assumes that the customer will purchase a lamp. This assumption therefore does not capture the possibility that the program itself induced the purchase of the lamp. This assumption is predicated on the expectation that the upstream programs do not increase the overall volume of installed statewide lamps (there are only so many sockets in IOU territory to draw power and thus produce efficiency savings).

In prior evaluations, we considered the gross and net savings baseline relative to lamps that were replaced by program-discounted lamps. We then used Lamp Choice Model results to estimate a NTGR that represents the relative percent changes in a given technology's market shift. In the 2015 impact evaluation, we used the Lamp Choice Model results to calculate a net savings market baseline. The 2017 evaluation uses the retail baseline as the only baseline. Therefore, in the 2017 evaluation, we use the Lamp Choice Model to calculate both gross and net savings estimates. We generated simulations based on 2016 consumer telephone survey results.[21] This enhancement allowed us to increase the rigor of our model results in the absence of supplier results.

[20] Please see CEC 2019 for further details on Title 20 and CEC 2018 for further details on lamp efficacy standards.

[21] We conducted the telephone surveys with a representative sample of 578 PG&E, SCE, and SDG&E residential electric customers as part of the 2015 evaluation.

Table 3-3 lists the strengths and weaknesses of the model-based net savings approach. Appendix F provides the coefficients for the Lamp Choice Model and provides more detail regarding Lamp Choice Model methodology.

Table 3-3. Strengths and weaknesses of the model-based net savings approach

Strengths	Weaknesses
• *Intercept surveys inform the model estimation:* We used information from consumers making purchasing decisions in California retail stores to estimate the model. This information is as close to real-time consumer purchasing decisions as possible. • *Responses from representative sample of California consumers used to simulate choices:* We simulated lamp purchases using demographics and store locations as reported by California lamp shoppers during our 2016 phone and online consumer surveys. • *Directly models consumer choices:* Upstream programs attempt to influence consumer choices. Logit models are the preferred analytical method for quantifying how a program signal can move consumers from one lamp technology to another. • *Captures differences in shopper populations by retail channel:* The model specification captures differences in choice-making among consumers by income group, homeowner versus renter status, and planned versus impulse purchasing decisions. The model specification is sensitive to differences in the population that shops in retail stores from channel to channel (capturing, for example, differences among shoppers in the discount channel versus the home improvement channel). • *Simulation based on up-to-date retail stocking information:* We built the simulation using shelf survey data from a representative sample of California retail stores that sold replacement lamps during the 2015 program period. These data record the distribution of lamp models and prices at each store, and these ground our analyses in the choices that consumers faced during the program period.	• *Preference data may reflect biases that would not be present in sales data:* The evaluation team is not aware of a comprehensive data source representing retail lamp sales from all of California's major lighting retailers. As such, we cannot confirm the extent to which survey respondents' stated choices under different conditions reflect actual retail sales volumes (e.g., whether they still would have purchased the same lamp when we altered their available options in our choice sets). • *The model does not explicitly represent sales volume:* The model predicts market shares. As such, the model does not endogenously account for the different volumes of program shipments. • *The model does not comprehensively address substitution between program and non-program lamps:* Some stores (such as those in the home improvement channel) have more non-program lamps than program-discounted lamps. The model does not handle this market situation as well as situations in which the volume differences are less skewed.

4 MEASURE QUANTITY ADJUSTMENT

An important part of the upstream evaluation is to verify and adjust the quantity of measures claimed in the program tracking data. This evaluation included a major quantity adjustment not required in prior evaluations that we refer to as a "sales-to-shipment ratio" for the discount and grocery channels in SCE and SDG&E territory. As in prior evaluations, the evaluation applied a residential and non-residential split for all upstream measures and applied an installation rate to all upstream measures.

4.1 Sales-to-shipment ratio

4.1.1 Overview

The evaluation team's analysis of the final 2017 program tracking data revealed unusually large volumes shipped to many small stores in SCE and SDG&E territories, which prompted the need for additional research and analysis.

The team developed the CPUC Group A Lighting Work Plan[22] in summer 2018 and released the workplan for public review in September 2018. We developed the work plan using program tracking data through third quarter 2017. Similarly, we developed the Data Collection and Sampling Plan[23] using the 2017 third quarter tracking data and posted to basecamp at the beginning of November 2018.

The final upstream lighting tracking data released for program year 2017 included changes from the 2017 third quarter data. Some of the more significant changes that we observed included the following:

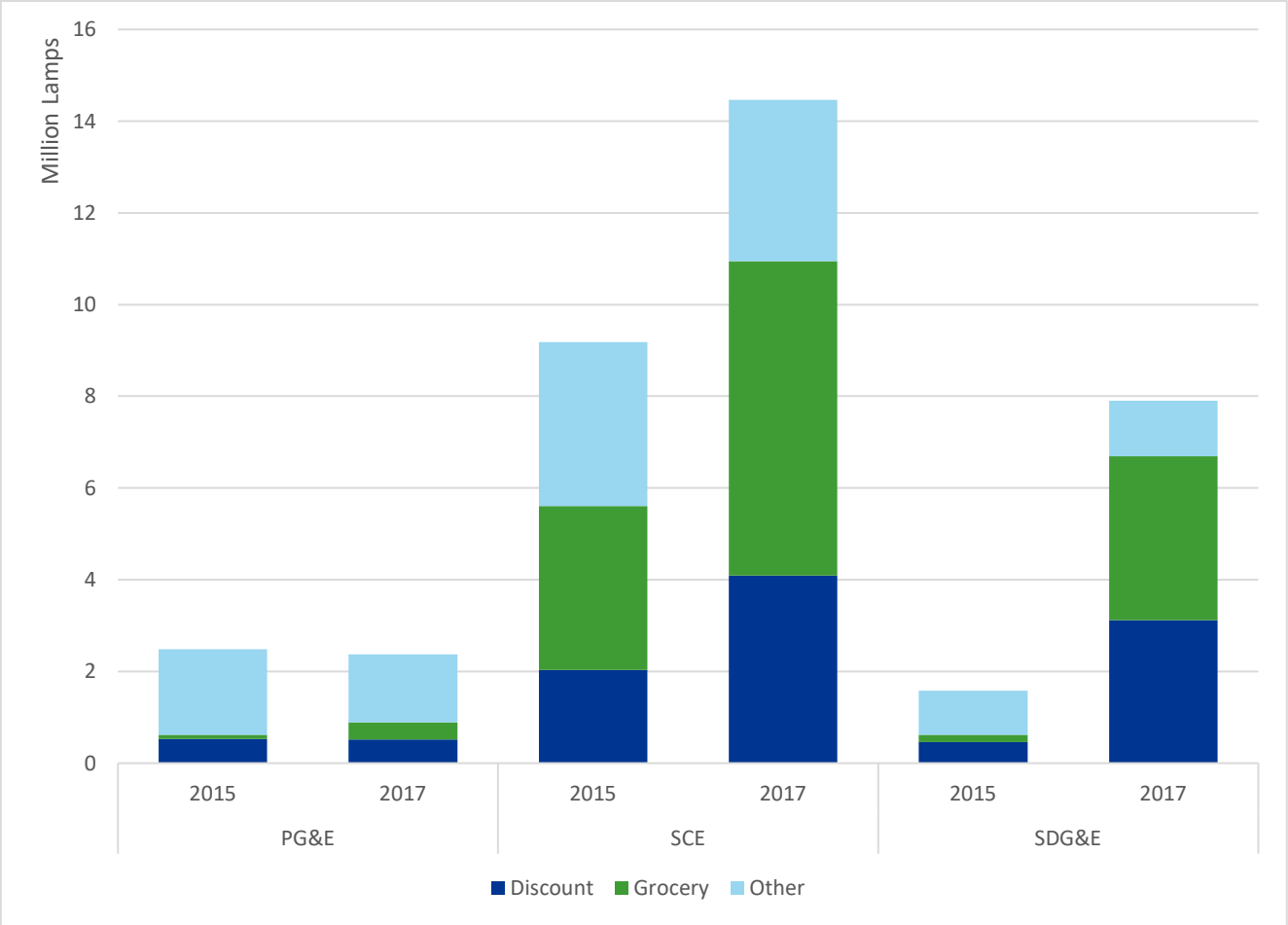
- 3.7 million high wattage CFLs were part of the SCE program that were not included in the third quarter data used to develop the workplan.
- SDG&E's program increased from 33GWh of gross savings in the third quarter data to 166GWh in the final tracking data.

The changes in measure mix and program delivery from the updated data raised questions about sell-through rates for high wattage CFLs, and for all lamps in the grocery and discount channels. In particular, these channels include many small stores, and many of the individual shipment volumes seemed unrealistic for these stores to carry.

Figure 4-1 shows the quantity of lamps shipped by channel and PA in 2015 and 2017. SCE increased the number of lamps it shipped by over 50% in 2017 compared to 2015, and SDG&E shipped approximately five times the number of lamps in 2017 than it did in 2015. Also notable is that SCE nearly doubled the number of lamps it shipped to discount and grocery stores in 2017, and SDG&E shipped more than ten times as many lamps to these two channels in 2017 compared to 2015. Shipments to all other channels combined were fairly similar across the two periods for SCE and SDG&E.

[22] DNV GL 2018b.
[23] DNV GL 2018a.

Figure 4-1. Quantity of lamps in evaluated upstream lighting measure groups by channel and PA, 2015 and 2017



To address the issue of unusually large quantities of lamps being shipped to discount and grocery stores, we calculated and applied a sales-to-shipment quantity adjustment to align the quantity of measures discounted and shipped in the upstream lighting program with the sales volume that the California replacement lamp market can accommodate. To calculate the sales-to-shipment ratio, the evaluation team leveraged the data sources in Table 4-1.

Table 4-1. Datasets, sources, and value points used in calculating the sales-to-shipment ratio.

Dataset	Source	Analysis
California Lamp Sales Data	Consortium of Retail Energy Efficiency Data (CREED)*	Estimated top down total sales volume in California and select metro areas
SCE and SDG&E participating discount and grocery store lamp inventory and sales	Store Manager Survey**	Estimated total lamp sales volume within the stores that participated in the program in these sales channels
California lamp purchase locations	2016 Consumer Survey***	Estimated where consumers buy lamps by channel
California statewide retail lamp stock inventory	2008-2016 Shelf Surveys****	Reviewed statewide stocking patterns

* Please see Appendix H for more information on the CREED sales data and a breakdown of POS estimates by select metro areas.
** To view the store manager survey instrument, please see Appendix E.
*** For further details on the 2016 Consumer Survey approach, please see Appendix C in DNV GL 2017b.
**** DNV GL 2019. For an overview of the shelf survey data and to access historical data, please see the California Retail Lighting Shelf Survey Online Tool available at: https://webtools.dnvgl.com/projects62/Default.aspx?tabid=221

4.1.2 Size of the California lighting market

Apex Analytics compiled sales data for California in 2017 through the Consortium of Retail Energy Efficiency Data (CREED). The data included point-of-sales (POS) data for select retailers from discount, drug, grocery, mass merchandise, and select membership club channels (POS estimate). The data also included a panel estimate of sales from other channels in the market, which included home improvement, hardware, and online stores, and remaining stores not included in the POS dataset (non-POS estimate). Table 4-2 shows a breakdown of total lamp sales in California by technology and lamp shape for the POS and non-POS estimates as well as the combined total sales from the POS and non-POS datasets.

Table 4-2. California replacement lamp sales estimates, 2017

Technology	Lamp Shape	POS Estimate	Non-POS Estimate	Total CA Sales
CFL	Greater than 30W	105,567	11,160,520	11,922,276
	All other CFL	656,189		
LED	A lamp	6,198,713	42,069,024	49,448,445
	Reflector	737,942		
	All other LED	442,765		
Halogen	All halogen	9,436,167	39,499,744	48,935,911
Incandescent	All incandescent	8,494,917	4,230,210	12,725,127
Total Sales		**26,072,261**	**96,959,498**	**123,031,759**

4.1.3 Discount and grocery channels market capacity compared with program volumes

Table 4-3 shows a breakdown of estimated lamp market sales and program lamp shipments in California in 2017. We used the CREED sales data estimate of the entire California lamp market and 2016 consumer surveys to estimate discount and grocery store sales. The table also shows the total program shipments in

those channels in 2017. When comparing the estimated sales to the program shipments, it becomes clear that SCE and SDG&E discounted and shipped more lamps than these channels could support.

Table 4-3 Estimated California lamp market size (sales) and program shipments for discount and grocery channels, 2017

Retail Channel and Data Source	Estimated Statewide Lamp Sales Range (Million)	Program Shipments (Million)			
		PG&E	SCE	SDG&E	Total
Discount Stores*	3-4	0.5	4.1	3.3	**7.7**
Grocery Stores*	3-4	0.4	6.9	3.6	**10.9**
Total California Market**	120 - 125				

*Consumer survey results show 3% of consumers buy their lightbulbs in the discount channel.
** CREED sales data.

4.1.4 Distribution of shipments to individual stores

The evaluation team also reviewed the quantity of lamps that programs shipped to each individual store. Table 4-4 breaks down the number of stores in the discount and grocery channel by bins of total program lamps shipped. To give an example of how program lamp shipments and lamp sales relate to one another, a store receiving 5,000 lamps would need to sell nearly 15 lamps every day of the year to sell through that volume of lamps. Combined, SCE and SDG&E shipped over 5,000 lamps to over 1,000 discount and grocery store fronts. SCE and SDG&E collectively shipped more than 10,000 discounted lamps to 171 different store fronts, with some stores receiving up to 150,000 lamps at an individual store. Taken together, these data reveal that the market could not support the lamp sales required to sell through the volume of lamps included in the 2017 program.

Table 4-4 Number of discount and grocery stores receiving program lamps by PA, binned by quantity of shipped program lamps, 2017

Range of Lamps Shipped to Individual Store	Count of Participant Stores			Total Quantity of Discounted Lamps		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Discount Stores						
1-1,000	449	799	101	149,735	491,767	72,534
1,001 – 5,000	188	764	186	362,886	1,709,507	537,362
5,001 – 10,000	0	249	61	0	1,784,610	447,296
Greater than 10,000	0	10	63	0	107,432	2,255,484
Total	**637**	**1,822**	**411**	**512,621**	**4,093,316**	**3,312,676**
Grocery Stores						
1-1,000	190	104	469	43,724	55,943	283,842
1,001 – 5,000	101	1,088	404	211,668	3,184,843	1,045,588
5,001 – 10,000	19	472	194	122,804	3,295,786	1,308,688
Greater than 10,000	0	25	73	0	318,310	955,494
Total	**310**	**1,689**	**1,140**	**378,196**	**6,854,882**	**3,593,612**

4.1.5 Sales-to-shipment ratios determined from store manager surveys

Tables 4-3 and 4-4 provide evidence that SCE's and SDG&E's 2017 discount and grocery shipments exceeded the capacities of these channels. However, this information does not provide a firm basis for adjusting the shipments to likely sales levels. To develop this adjustment factor, the evaluation team conducted a telephone survey of store managers of discount and grocery stores that participated in the 2017 SCE and SDG&E upstream lighting programs.[24] For the survey, we designed a sample that would be representative of participating stores. See Section 3.3 for the sample targets and actual completes. We asked the managers to estimate their weekly lamp sales and describe what their store does with any unsold lamps. From these data, we calculated the ratio of annual sales capacity to 2017 program shipments, by PA, channel, and subchannel (independent vs chain store). We applied this sales-to-shipment ratio as a quantity adjustment factor for each of these segments.

Table 4-5 shows the results from the store manager survey. Most survey respondents provided estimates of weekly lamp sales as a range. We multiplied the high value of range estimates by 52 to obtain yearly sales estimates. The sales-to-shipment ratio for each PA and sub-channel is calculated as a standard ratio estimate. Specifically, the numerator of the ratio is the weighted total of yearly sales calculated from the survey responses, using the sample-based expansion weights. The denominator of the ratio is the corresponding expansion-weighted total of shipments for the stores in the sample. We show the standard errors of these ratios in the table below.

Table 4-5 - Store manager survey results by PA and chain and independent channel

PA and Channel	Completed Surveys	Program Participa-ting Stores	Program Shipments	Weighted Shipments	Weighted Sales Estimate	Sales-to-Shipment Ratio	Ratio Standard Error
SCE	34	1,251	10,948,198	11,432,511	1,839,101	0.16	0.052
Chain Discount	14	403	1,577,685	1,156,379	923,698	0.80	0.307
Chain Grocery	9	176	1,621,930	1,435,019	645,871	0.45	0.330
Independent Discount	5	215	2,528,869	2,820,026	122,980	0.04	0.018
Independent Grocery	6	457	5,219,714	6,021,086	146,551	0.02	0.011
SDG&E	49	580	6,906,288	6,723,296	346,288	0.05	0.015
Chain Discount	15	59	2,855,378	2,097,590	119,346	0.06	0.031
Chain Grocery	5	21	500,234	412,331	28,392	0.07	0.037
Independent Discount	11	52	457,298	364,484	39,354	0.11	0.045
Independent Grocery	18	448	3,093,378	3,848,890	159,196	0.04	0.018

Table 4-5 above shows that the ratios of sales-to-shipments were different for independent stores than for chains, particularly for SCE. This was the reason to produce separate ratios by subchannel. We then combined the subchannel ratios to provide channel-level ratios, weighting each subchannel ratio in proportion to its total known shipments.

Table 4-6 shows the channel-level sales-to-shipment ratios. These are the ratios that were applied to the quantities in the discount and grocery sales channels. For SCE, we applied a 33% quantity adjustment in the

[24] We did not conduct telephone surveys with discount and grocery store managers in PG&E's service territory because the total quantity of program-discounted lamps that PG&E shipped in 2017 did not exceed the market capacity for replacement lamps in discount and grocery stores.

discount channel and a 13% quantity adjustment in the grocery channel. For SDG&E, we applied a 6% quantity adjustment in the discount channel and a 5% quantity adjustment in the grocery channel.

Table 4-6 - Store manager survey results by aggregated channel

PA and Channel	Completed Surveys	Program Participating Stores	Program Shipments	Weighted Shipments	Weighted Sales Estimate	Sales-to-Shipment Ratio	Ratio Standard Error
SCE	34	1,251	10,948,198	11,432,510	1,839,100	.20	
Discount	19	618	4,106,554	3,976,405	1,046,678	**.33**	0.191
Grocery	15	633	6,841,644	7,456,105	792,422	**.13**	0.161
SDG&E	49	580	6,906,288	6,723,295	346,288	.05	
Discount	26	111	3,312,676	2,462,074	158,700	**.06**	0.033
Grocery	23	469	3,593,612	4,261,221	187,588	**.05**	0.021

Table 4-7 shows the effect of the sales-to-shipment quantity adjustments that we applied to the discount and grocery channels for SCE and SDG&E.[25] The affected channels are highlighted in green. The quantity adjustments resulted in a significant decrease in the number of lamps that are credited with savings.

[25] Because PG&E's 2017 lamp shipments to discount, grocery, and other channels did not exceed the expected market capacity for lamps in those channels, we did not apply a sales quantity adjustment to PG&E lamps.

Table 4-7. Discount and grocery lamp quantity adjustments by PA, 2017

PA and Channel	Evaluated Measures Lamps Shipped	Sales Quantity Adjustment	Evaluated Measures Lamps Credited
PG&E			
Discount	512,621	100%	512,621
Grocery	378,196	100%	378,196
Remaining Channels	1,476,566	100%	1,476,566
Total	**2,367,383**	**100%**	**2,367,383**
SCE			
Discount*	4,091,691	33%	1,365,553
Grocery*	6,851,618	13%	858,291
Remaining Channels**	3,521,574	100%	3,521,574
Total	**14,464,883**	**40%**	**5,745,418**
SDG&E			
Discount	3,312,676	6%	211,837
Grocery	3,491,374	5%	157,772
Remaining Channels	1,097,727	100%	1,097,727
Total	**7,901,777**	**19%**	**1,467,336**

*Excludes all basic CFL measures as they did not exceed reasonable sales capacity of these channels.
**Includes all measures as they did not exceed reasonable sales capacity of these channels.

4.1.6 PA verification data

4.1.6.1 PG&E

PG&E's entire Primary Lighting program was much smaller than SCE's and SDG&Es, and PG&E did not ship quantities to discount and grocery stores that would exceed the lighting market potential for these channels. We therefore did not request to review PG&E upstream lighting verification data.

4.1.6.2 SCE

Because SCE's Primary Lighting program did appear to exceed reasonable estimates for the discount and grocery store channels, we requested that they submit any verification data related to Primary Lighting lamps. SCE maintains a database from on-site visits that verifies the quantities of program lamps that participating stores have on display and in stock. To our knowledge, these site visits are intended as spot checks, and are not meant to represent a statistically representative sample of the population. Nevertheless, through a formal data request, SCE provided evaluators with an extract of this database and we reviewed the database and compared it with tracking and store manager survey data. When working with the verification data, we noticed that some records reported blanks in the verified fields while other records reported 0's, and others reported positive, whole numbers. We assumed that blank values meant that the surveyor did not consider those lamps in their verification visit, and we omitted the associated shipped quantities from this analysis. We thus omitted 2,228 records (accounting for 2,567,365 lamps) in the

verification database that were missing numeric verified values, and only considered 1,917 records and their associated 2,141,859 lamps as part of this analysis. Table 4-8 provides a summary of the records that we considered verified and not verified.

Table 4-8. SCE records and lamp quantities verified, SCE self-verification data

Unit	Database Records	Shipped Lamps
In Database	4,145	4,709,224
Not Verified	2,228	2,567,365
Verified	**1,917**	**2,141,859**

In addition to omitting records without verified quantities, we found that some records reported verified quantities that exceeded the quantities of reported shipped lamps. In these instances, we set the quantity of verified lamps equal to the quantity of shipped lamps. See Table 4-9 for details.

Table 4-9. SCE records and lamp quantities where verified quantities were less than, equal to, or greater than shipped quantities, SCE self-verification data

Unit	Database Records	Shipped Lamps
Verified Equal or Less than Shipped	1,515	1,961,935
Verified Greater than Shipped	402	179,924
Verified in Database	**1,917**	**2,141,859**

Table 4-10 below presents the findings from this analysis. The results indicate that the internal SCE verification visits align with the findings from the evaluation's store manager surveys. In the discount channel, SCE staff were only able to verify 21% of shipped lamps (both on display and in storage) at the participating stores. In the grocery channel, SCE staff was only able to verify 23% of shipped lamps at the participating stores. It is also notable that verification rates drop across all channels as store shipments rise above 5,000 lamps. We found that a clear trend emerged; namely, the percentage of shipped lamps that SCE verified decrease steadily as the lamps-per-store bins increase. In other words, stores that received 1-1,000 lamps on average saw above 50% verification rates across all channels.

In contrast, stores that received 10,000 or more lamps on average observe verification rates at 11% or lower. These data align with store manager interviews and suggest that selling more than 100 lamps per week is an unrealistic expectation for any store, particularly in stores where lamps bought tend to be impulse purchases, such as discount, drug, and grocery stores. While the verification data are not designed to be statistically significant, they do suggest that stores in channels other than discount and grocery stores also struggled to stock and sell the quantities that programs claimed. Due to the lack of additional statistically significant data to assign a reduction to these channels, we did not make adjustments to sales channels beyond discount and grocery.

Table 4-10. SCE lamp quantities accounted for in SCE self-verification data

Range of Lamps Shipped to Individual Store	Count of Stores	Quantity of Lamps Shipped	Quantity of Lamps Verified	Average Verified Lamps per Store	Percent of Shipped Lamps Verified
Discount Stores					
1-1,000	29	7,826	6,077	210	78%
1,001 – 5,000	37	110,391	42,143	1,139	38%
5,001 – 10,000	24	154,609	23,528	980	15%
Greater than 10,000	9	135,592	15,583	1,731	11%
Total	**99**	**408,418**	**87,331**	**882**	**21%**
Drug Stores					
1-1,000	0	N/A	N/A	N/A	N/A
1,001 – 5,000	52	135,168	53,516	1,029	40%
5,001 – 10,000	0	N/A	N/A	N/A	N/A
Greater than 10,000	1	26,520	836	836	3%
Total	**53**	**161,688**	**54,352**	**1,026**	**34%**
Grocery Stores					
1-1,000	7	4,903	2,687	384	55%
1,001 – 5,000	73	256,543	78,062	1,069	30%
5,001 – 10,000	35	206,917	40,511	1,157	20%
Greater than 10,000	8	119,736	12,346	1,543	10%
Total	**123**	**588,099**	**133,606**	**1,086**	**23%**
Hardware Stores					
1-1,000	11	6,816	4,215	383	62%
1,001 – 5,000	34	83,650	29,895	879	36%
5,001 – 10,000	10	79,196	6,058	606	8%
Greater than 10,000	12	174,036	19,396	1,616	11%
Total	**67**	**343,698**	**59,564**	**889**	**17%**
Home Improvement Stores					
1-1,000	45	26,623	15,425	343	58%
1,001 – 5,000	28	63,247	19,697	703	31%
5,001 – 10,000	1	8,960	449	449	5%
Greater than 10,000	1	22,896	1,692	1,692	7%
Total	**75**	**121,726**	**37,263**	**497**	**31%**
Mass Merchandise					
1-1,000					
1,001 – 5,000					
5,001 – 10,000					
Greater than 10,000					
Total					
Membership Club Stores					
1-1,000	0	N/A	N/A	N/A	N/A
1,001 – 5,000	2	5,584	1,416	708	25%
5,001 – 10,000	6	48,960	3,106	518	6%
Greater than 10,000	27	463,686	50,179	1,858	11%
Total	**35**	**518,230**	**54,701**	**1,563**	**11%**

In addition to supporting our sales-to-shipment ratio analysis, we observed two concerns regarding SCE's verification data. First, as noted above, 402 of 1,917 verified records reported verified quantities that were higher than the reported shipped quantities.

Second, we found that quantities that appear in the tracking data are substantially different from quantities in the verification database. SCE's verification data and the tracking data did not have a clear identification variable to merge these two datasets comprehensively. As a spot check, we manually merged SCE verification data to tracking data for the stores included in our store manager surveys. Among stores that we contacted for this survey, we found 18 sites in SCE's verification data. In aggregate, the tracking data for these sites reported higher shipped quantities than the verification database.

Table 4-11 contains a subset of stores from the verification data. The table shows the quantities of lamps in the SCE tracking database and SCE verification database by channel and chain/independent store type among all records matched between the subset of sites in the databases. Across this subset, the quantities in the verification database represent only 63% of lamps that SCE reported in the tracking data. If we were to extrapolate the shipped quantities in the verification data to reflect the tracking data quantities, the verification rates would be even lower.

Table 4-11. SCE lamp shipment quantities in tracking data versus SCE verification data

Store ID	Sum of lamps on display	Shipped Quantity in Tracking Data	Shipped Quantity in Verification Data
1	Chain Discount	2,926	2,186
2	Chain Discount	2,926	5,166
3	Chain Discount	1,560	240
4	Chain Discount	2,876	2,136
5	Chain Discount	2,876	240
6	Chain Discount	8,150	11,334
7	Chain Discount	280	280
8	Chain Discount	1,548	240
9	Chain Discount	1,548	240
10	Chain Discount	2,901	2,136
11	Chain Grocery	9,574	3,920
12	Chain Grocery	9,753	4,045
13	Chain Grocery	9,753	4,045
14	Chain Grocery	9,753	4,045
15	Chain Grocery	7,204	6,358
16	Independent Discount	3,384	2,772
17	Independent Grocery	7,864	1,620
18	Independent Grocery	10,272	8,484
Total		**95,148**	**59,487**

4.1.6.3 SDG&E

Because SDG&E's Primary Lighting program appeared to exceed reasonable estimates for the discount and grocery store channels, we requested that they submit any verification data related to Primary Lighting lamps. As of the publication of this draft on March 1, 2019, we have not received these data, but we anticipate receiving and reviewing them before we post the final report. We expect these data will be unstructured data, including mostly PDFs and scans of notes.

4.2 Residential vs non-residential

To estimate the portion of upstream lamps that are installed in non-residential applications, the 2010-12 evaluation relied on the results of two onsite survey studies conducted during the 2010-12 period—the CLASS[26] and the Commercial Market Share Tracking Study.[27] These efforts yielded the residential versus non-residential shares of total upstream lighting program measures shown in Table 4-12. As in the 2013-14 and the 2015 impact evaluations, we applied these estimates in this report.

Table 4-12. Ex post share of residential vs. non-residential upstream lighting measures by PA, 2017

PA	Ex Post	
	Non-residential	Residential
PG&E	7%	93%
SCE	6%	94%
SDG&E	6%	94%

4.3 Leakage

Leakage is defined as the quantity of program-discounted upstream lamps that "leak" out of the collective IOU service territories. Leakage was not a research priority for the 2017 impact evaluation. Due to the lack of data to support evidence of leakage, no adjustment to quantity has been applied to upstream program evaluations since the 2006-2008 impact evaluation report. For this evaluation, we have applied the same 0% leakage rate as in prior evaluations.

The 2017 evaluation has raised new questions about leakage. To some extent, leakage is being captured in the sales-to-shipment quantity adjustment factor, as bulbs that leaked out of PA service territory were likely captured in that analysis. However, during the analysis, concerns regarding leakage of shipments and overstock of lamps being moved to areas outside of the PA service territory arose. Additionally, we found some stores with large shipments within a quarter mile of a border crossing, suggesting sales to customers outside the PA service territory. Leakage will need to be addressed more rigorously in the 2018 impact evaluation.

4.4 Installation rate

For this evaluation, we applied installation rates that credit savings for lamps purchased within the 2017 program period regardless of whether consumers installed the lamps in 2017. This methodology eliminates

[26] DNV GL 2014a. See also Appendix F in DNV GL 2017b for details regarding the CLASS sampling approach.

[27] Itron, Inc. 2014.

the need for an installation-based carry-over analysis, and we first adopted it in the 2010-12 impact evaluation.

DNV GL addressed CFL and LED lamp installation rates as part of the 2015 impact evaluation. We addressed installation rates in the 2016 consumer telephone and online surveys (the former for most CFLs and LED lamps and the latter high wattage CFLs).[28] Specifically, we attempted to quantify the percentage of lamps that will never be installed. We subtract this value from 100% to yield the installation rate. The surveys asked respondents about the quantity of CFLs, LED lamps, and high wattage CFLs that they have installed, the quantity in storage, and how many will or will not be installed in the future.

Survey results suggest that 95% of CFLs in homes within PG&E, SCE, and SDG&E's residential electric service territories are or will eventually be installed (Table 4-13). For LED lamps, survey results indicate that 98% of lamps were installed at the time of the survey or will be installed in the future. We applied these installation rates to calculate gross savings.[29] For non-residential upstream measures, and residential downstream lighting measures, we passed through the ex ante installation rates.

Table 4-13. Residential upstream CFL and LED lamp installation rates (2016 consumer telephone survey)

Classification	CFLs in Household	LED Lamps in Household
	Percent (n=317)	Percent (n=267)
Installed	77%	90%
In storage, will be installed	18%	8%
Will never be installed*	5%	2%
Total Lamps in Household	100%	100%

* "Will never be installed" includes those in storage consumers will never install plus those that they expect to throw away or give away.

Table 4-14 shows ex ante and ex post installation rates for 2017 upstream lighting measures by PA and sector for each measure group. For CFL measure groups, ex ante installation rates varied by PA, and ranged from 67% to 77% for CFL measures. The ex post estimate installation rate for CFLs of 95% is higher than the ex ante value of 67% and 77% for PG&E and SCE, respectively. For all LED lamp measure groups, installation rate estimates were 2 percentage points lower for ex post versus ex ante (98% versus 100%, respectively).

[28] Please refer to Section 3.4 above for details regarding the consumer telephone and online survey approaches.

[29] Note that we applied the CFL installation rate across both CFL measure groups and the LED lamp installation rate across both LED measure groups.

Table 4-14. Ex ante and ex post residential and non-residential installation rates by PA and upstream lighting measure group, 2017

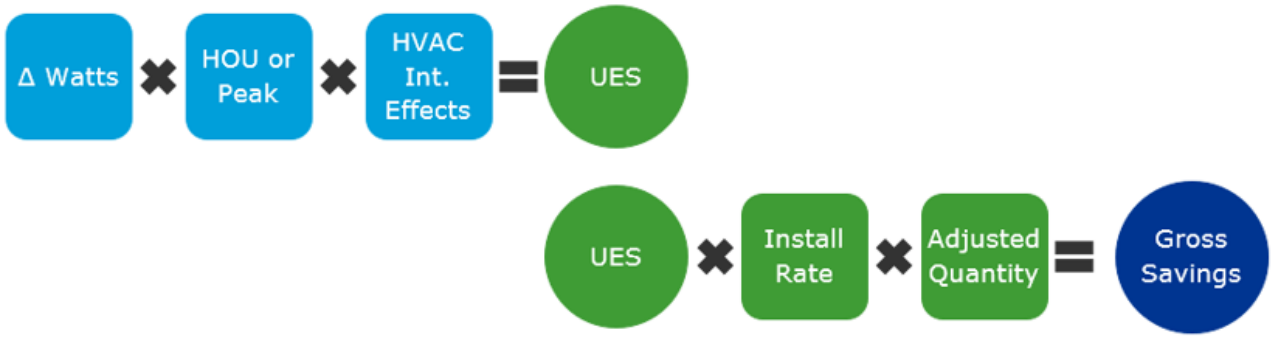
PA	Evaluated Upstream Lighting Measure Group	Residential		Non-residential	
		Ex Ante	Ex Post	Ex Ante	Ex Post
PG&E	CFL high wattage (> 30 W)	67%	95%	73%	73%
	LED A-lamp, all wattages	100%	98%	100%	100%
	LED reflector, all wattages	100%	98%	100%	100%
SCE	CFL basic spiral ≤ 30 W	77%	95%	81%	81%
	CFL high wattage (> 30 W)	77%	95%	81%	81%
	LED A-lamp, all wattages	100%	98%	100%	100%
	LED reflector, all wattages	100%	98%	100%	100%
SDG&E	CFL high wattage (> 30 W)	67%	95%	73%	73%
	LED A-lamp, all wattages	100%	98%	100%	100%
	LED reflector, all wattages	100%	98%	100%	100%

5 GROSS SAVINGS ANALYSIS

5.1 Overview

This section of the report focuses on the gross savings methods and results for the PAs' 2017 upstream and residential downstream lighting programs. Figure 5-1 below shows the components of the gross savings assessment.

Figure 5-1. Gross savings overview



We calculate gross savings using an estimate for UES, an evaluated installation rate, and an adjusted quantity factor. We define the UES for each measure group as the product of three parameters, namely: delta watts (Δ watts), annual hours of use (HOU) or peak coincidence factor (CF), and HVAC interactive effects (IE). The equations for these calculations are presented below in Equation 5-1 through Equation 5-4.

Equation 5-1. Gross unit energy savings

$$UES_L\left[\frac{kWh}{year}\right] = \Delta Watts_L[W] * HOU_L[h] * \frac{1\ kWh}{1000\ Wh} * \frac{365\ days}{1\ year} * IE_L[kWh]$$

Where:

$\Delta Watts_L$ = average displaced (delta) wattage for PA-discounted lamp measure group, L, in watts (W)

HOU_L = annual average HOU for PA-discounted lamp measure group, L, in hours (h)

IE_L = HVAC interactive effects factor

Equation 5-2. Gross savings

$$Gross\ savings_L[kWh] = UES_L[kWh] * IR_L * Q_L$$

Where:

UES_L = unit energy savings for lamp measure group, L (see Section 0)

IR_L = installation rate for lamp measure group, L

Q_L = rebated measure quantity for lamp measure group, L

Equation 5-3. Gross peak unit energy savings

$$UES_L\left[\frac{kW}{year}\right] = \Delta Watts_L[W] * CF_L * \frac{1\,kW}{1000\,W} * IE_L[kW]$$

Where:

$\Delta Watts_L$ = average displaced (delta) wattage for PA-discounted lamp measure group, L, in watts (W)

CF_L = average percent on at peak for PA-discounted lamp measure group, L

IE_L = HVAC interactive effects factor

Equation 5-4. Gross peak demand reduction

$$Gross\ savings_L[kW] = UES_L[kW] * IR_L * Q_L$$

Where:

UES = unit peak demand reduction for lamp measure group, L (see Section 0)

IR_L = installation rate for lamp measure group, L

Q_L = rebated measure quantity for lamp measure group, L

5.2 Hours of use

We use the average daily HOU to calculate UES based on the operating hours for each relevant measure group. For this evaluation, as in the 2015 impact evaluation, we estimated population-level average daily HOU by measure group using an ANCOVA model fit to metered lamp use, for residential savings estimates. We applied the ex ante UES for non-residential savings estimates, so this section of the report applies only to residential savings estimates. This report reflects the changes we made to developing HOU estimates for the 2013-14 impact evaluation, which include:

- Developing HOU estimates for high wattage CFLs (> 30 W) as well as a measure group for all types of LED lamps.
- To account for changes in the lower-wattage CFL measure groups with the removal of the high wattage lamps, developing HOU estimates for basic spiral CFLs ≤ 30 W, A-lamp CFLs ≤ 30 W, and reflector CFLs ≤ 30 W

The ANCOVA model used logger data HOU profiles from the 2010 Residential Lighting Metering Study,[30] [31] and lamp installation locations from the 2012 CLASS residential lamp inventory.[32] HOU estimates by measure group take into account lamp types as well as room location and usage within the population; for example, for a reflector CFL ≤ 30 watts located in a dining room, we applied the usage profile that we generated for CFL reflectors ≤ 30 watts in dining rooms.

Sample sizes in the 2010 metering study were insufficient to model LED A-lamp and LED reflector lamp usage profiles, and DNV GL is aware of no other available sources that estimate LED lamp hours of use in California. Lamp usage varies by installation location, so we applied the CFL usage profiles from the 2010 metering study to the LED lamps in the 2012 CLASS inventory based on installation locations to yield LED lamp usage profiles (as was done in the 2015 impact evaluation report).

The model produced estimates at the statewide level and for each PA. For all CFL measure groups ≤ 30 W, we applied HOU estimates at the PA level. Because LED lamps and high wattage CFLs >30 W were present in lesser quantities in the 2012 CLASS data than lower-wattage CFLs, confidence intervals were too broad to support PA-specific estimates for these measure groups. As a result of small sample sizes, the data do not support reporting on LED lamps by lamp shape. Table 5-1 provides an overview of the HOU results, including confidence intervals (CI).

Table 5-1. Residential lighting HOU estimates by evaluated upstream lighting measure group and PA, 2017

Evaluated Upstream Lighting Measure Group	PG&E		SCE		SDG&E		Overall	
	HOU	90% CI	HOU	90% CI	HOU	90% CI	HOU	90% CI
CFL basic spiral ≤ 30 W	1.6	±0.1	1.9	±0.2	1.4	±0.2	1.7	±0.1
CFL high wattage (> 30 W)*	*	*	*	*	*	*	1.9	±0.2
LED A-lamp, all wattages*	*	*	*	*	*	*	2.1	±0.2
LED reflector, all wattages*	*	*	*	*	*	*	2.1	±0.2

* The table presents high wattage CFL, LED A-lamp, and LED reflector lamp measure groups across all PAs as a result of small sample sizes in the 2010 metering study for measures in these groups. In these cases, we applied the overall estimates in calculating impacts. Please refer to Appendix E in the 2015 lighting impact evaluation for more details regarding metering study sample sizes (DNV GL 2017b).

5.3 Peak coincidence factor

Peak CF represents the average percent of time that a lamp is switched on during the peak period, which varies by climate zone. Similar to our approach for HOU estimates, we derived CF estimates for LED lamps and high wattage CFLs from the logger data collected for the 2010 metering study and applied these estimates to the lighting inventory data collected during CLASS 2012. Again, high wattage CFL, LED A-lamp, and LED reflector lamp inventories were too small to create valid estimates by lamp shape or by PA, so we applied the overall estimates (across PAs) in calculating impacts as we did in the 2015 impact evaluation report. Table 5-2 shows the final peak CF values for 2017.

[30] KEMA, Inc. and Cadmus Group, 2010. The study included 1,200 households recruited randomly throughout California over three overlapping waves of data collection from July 2008 through December 2009. Please refer to for more details regarding metering study sample sizes.

[31] While more current metering data would certainly be preferable, these data are not available. In the absence of more current data, DNV GL believes that adjustments to the 2010 study's metering results based on updated lamp disposition (by installation location) from the CLASS study provide the most accurate representation available for residential lamp usage in California.

[32] DNV GL 2014a.

Table 5-2. Residential lighting peak CF by evaluated upstream lighting measure group and PA, 2017

Evaluated Upstream Lighting Measure Group	PG&E		SCE		SDG&E		Overall	
	Peak CF	90% CI	Peak CF	90% CI	Peak CF	90% CI	Peak CF	90% CI
CFL basic spiral ≤ 30 W	0.05	±0.01	0.07	±0.01	0.04	±0.02	0.06	±0.01
CFL high wattage (> 30 W)*	*	*	*	*	*	*	0.06	±0.01
LED A-lamp, all wattages*	*	*	*	*	*	*	0.06	±0.02
LED reflector, all wattages*	*	*	*	*	*	*	0.06	±0.02

* The table presents high wattage CFL, LED A-lamp, and LED reflector lamp measure groups across all PAs as a result of small sample sizes in the 2010 metering study. In these cases, we applied the overall estimates in calculating impacts. Appendix E in the 2015 lighting impact evaluation for more details regarding metering study sample sizes (DNV GL 2017b).

5.4 Delta watts methodology with example

In this section, we outline the delta watts methodology, and due to the change in baseline approach, we will provide an example of LED A-lamp results alongside the description of the methodology. The delta watts parameter establishes the difference in demand between the inefficient non-program technology's wattage (the baseline) and the efficient program technology's wattage (the rebated wattage). While prior evaluations used *in-home* inefficient lamps to calculate the baseline wattage, this evaluation uses *retail* inefficient lamps that program lamps displaced to calculate the baseline wattage. Note that in the 2015 evaluation, we applied this same methodology as part of the net-savings adjustment factor (which we referred to as the unit energy savings NTGR).[33]

The May 2017 screw in lamp disposition[34] set the ex ante baseline for lamps greater than or equal to 90 lumens per watt[35] at 75% CFL and 25% halogen and the baseline for lamps with less than 90 lumens per watt at 55% CFL, 20% LED, and 25% halogen. By including the program technology in the baseline, the disposition essentially incorporated the free-ridership adjustment into the gross savings estimate. The 2017 disposition accounted for this by raising net-to-gross ratios to above 90%. The overall impact of the changes from the disposition were lowered gross savings and increased net-to-gross ratios with roughly equal overall net savings. This evaluation was designed to align more closely with this framework than prior evaluations and provide meaningful metrics and insights into program performance. We developed the retail baseline described in this section. However, we found that the disposition baselines implicitly contained a measure of free-ridership in the gross savings. This evaluation produces estimates for gross and net savings that are clearer and more defined than those from the 2017 disposition.

In the 2017 evaluation, we use the retail baseline as the gross savings baseline. A retail baseline is a better representation of the reality that upstream lighting programs target consumers who are making purchases, and assumes that in the absence of the program, customers would have still purchased a lamp. The program year 2017 delta watts methodology accounts for the average wattage of non-program lamps based on retail stocking data, weighted by counterfactual market shares that each alternative non-program comparable lamp type would have secured had the program not been active. We use our Lamp Choice Model to estimate market shares for each of the competing lamp technologies.

[33] DNV GL 2017b.

[34] "Comprehensive workpaper disposition for Screw-in Lamps. Revisions to disposition originally issued March 1, 2017" California Public Utilities Commission, Energy Division. May 26, 2017. See http://deeresources.net/workpapers.

[35] The 2017 screw in lamp disposition uses lumens per watt as a way to scale assumptions across a wide range of measures.

We calculate one delta watts estimate for each measure group and each PA. We describe this methodology using the following steps:

1. Define actual program lamp wattage
2. Estimate lamp market shares with and without the program
3. Estimate displaced shelf wattage
4. Account for channel shift
5. Calculate delta watts after channel shift

We use the LED A-lamp measure group and the home improvement channel throughout our example to demonstrate this methodology in action.

5.4.1 Define program lamp wattage

We calculated the program wattage for each measure group and PA based on the average wattage of all discounted lamps in the group. Using the example of LED A-lamps, we show the average wattage for LED A-lamps in Table 5-3. This is the overall average across all measures discounted in the A-lamp measure group, which range from 3 watts to 23 watts.

Table 5-3. Example - average program lamp wattage, LED A-lamps 2017

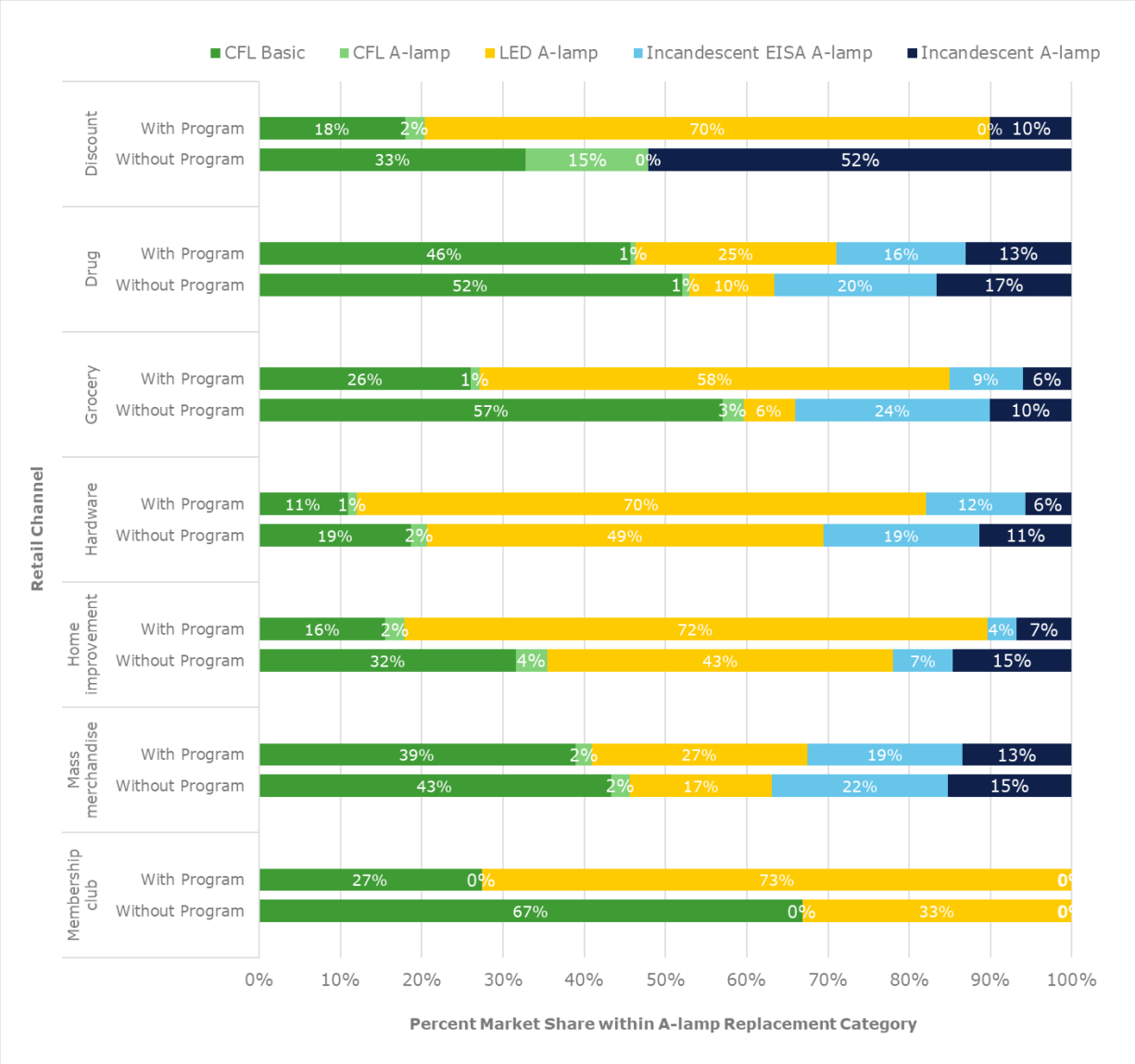
Channel	Average Program Lamp Wattage (Watts)
PG&E	10.0
SCE	9.9
SDG&E	14.4

5.4.2 Estimate lamp market shares with and without the program

We use the Lamp Choice Model to estimate the percent of the lighting market that each competing lamp technology secured under two scenarios. We first estimated market shares with the program discounts present, and we then estimated market shares with the program discounts removed, and program lamps at full price. This modeling approach allows us to consider what mix of technologies would have been purchased in place of the program lamps had the Upstream Lighting program not existed. The average wattage of these displaced lamps serves as the baseline to the delta watts calculation. Appendix F has the full methodological write-up for the Lamp Choice Model, and Figure 5-2, below, provides the results of the LED A-lamps market share estimates with and without program discounts.

Note that with program discounts present in the home improvement channel, LED A-lamps secured 72% of retail market share. Without discounts, the LED market share decreases to 43%. The relative market share gained by each alternative technology determines the weighting of that technology's wattage in the LED baseline wattage. The next subsection describes this calculation in more detail.

Figure 5-2. Example – Lamp Choice Model results, A-lamp replacement lamp category, all channels and PAs



5.4.3 Estimate displaced shelf wattage

For each measure group within a lamp replacement category and channel, we generated two sets of estimates:

- **Lamp displacement rates.** We assume that every incremental program-attributable lamp sold displaces the sale of an alternative technology that a consumer would have purchased in the absence of the program. The alternative technology sale might have been displaced from the program period or from a later year. For each program technology, we calculated what fraction of the incremental sales of that technology displaced each other lamp type in the replacement category. This is the program-

induced change of each other lamp's market share, as a percentage of the program-induced change of the measure group's market share. Because of the 1-1 displacement, the sum of market shares of other technologies displaced by each program technology is equal to the incremental market share of the program technology. That is, the displacement rates summed over the alternative technologies is equal to 100%.

- **Average on-shelf wattage.** For each technology, we calculated the average wattage of non-program lamps that California retail stores stocked during the winter 2015-16 period by retail channel, from the in-store shelf survey data.

We weighted the average wattage from the retail lamp stock inventories by the program lamp displacement rate to yield an overall average displaced market wattage by retail channel.

To illustrate this, we continue to use the example of the residential LED A-lamp measure group in the home improvement channel in Table 5-4 below. In this example, we see that the average on-shelf wattage of CFL basic spirals in home improvement stores was 16.4 Watts, while CFL A-lamps was 14.1 Watts, incandescent, EISA compliant was 49.1 Watts, and incandescent A-lamps was 54.7 Watts. The program increases the LED A-lamp share by 29 percentage points, from 43% to 72%. This increase comes from market share reductions of 16, 1, 4, and 8 percentage points, respectively, for the other technologies. The lamp displacement rates express these reductions as fractions of the total 29 percent market share displaced by the LED A-lamps. Weighting each alternative technology's wattage by its displacement rate produces the average wattage of lamp sales displaced by program LED A-lamps in home improvement stores: 30.8 W.

Table 5-4. Average displaced wattage for residential LED A-lamps in the home improvement channel, 2017

Channel / A-lamp Replacement Type	Market Share			Lamp Displacement Rates**	Average On-Shelf Wattage***
	With Program*	Without Program*	Difference**		
Home improvement					
CFL basic spiral ≤ 30W	16%	32%	16%	55%	16.4
CFL A-lamp ≤ 30W	2%	4%	1%	5%	14.1
LED A-lamp	72%	43%	-29%	N/A	N/A
incandescent, EISA compliant	4%	7%	4%	13%	49.1
incandescent A-lamp	7%	15%	8%	27%	54.7
Overall	**100%**	**100%**	**0%**	**100%**	**30.8**

*Lamp Choice Model
**Calculation
***Winter 2015-16 shelf surveys

5.4.4 Account for channel shift

The next step was to consider the impacts of channel shift. As we did in the 2015 evaluation, we made this adjustment for the membership club channel only and did so for all measure groups and PAs. We only consider channel shift in membership club for two reasons:

- The baseline wattage in membership club is drastically lower than the other channels; membership clubs have a CFL-only baseline for LED lamps and an LED-only baseline for CFLs.

- Supplier interviews revealed that up to 50% of membership club lamp sales occurred because of the price and availability of program lamps in these stores.

We consider it reasonable that 50% of membership club program lamp purchases would have occurred in different stores had the program not existed. To calculate the average market-displaced wattage, we use the 2016 consumer survey to estimate where California shoppers purchased lamps. We then calculate a channel-shifted purchase-location-share for all non-membership club channels. This represents the percent of channel-shifted program lamps that would have existed in each relative channel had the program not existed.

Table 5-5 shows the channel-shifted displaced wattage for membership-club LED A-lamp program lamps. This table shows that 58% of lamps that the program shifted into membership club stores would have sold in home improvement stores with an average wattage of 30.2 watts, while 22% of these lamps would have sold in mass merchandise stores with an average wattage of 30.4 watts. Overall, channel-shifted LED A-lamps have a baseline of 31.7 watts.

Table 5-5. Membership club channel-shifted displaced wattage for residential LED A-lamps, 2017

Channel	Typical Lamp Purchase Location	Channel-Shifted Purchase Location Share	Channel-Shifted Displaced Wattage
Discount	3%	3%	46.9
Drug	3%	3%	32.6
Grocery	3%	3%	28.6
Hardware	9%	10%	38.4
Home improvement	51%	58%	30.2
Mass merchandise	20%	22%	30.4
Membership club	11%		
Total	**100%**	**100%**	**31.7**

Note: Due to a nuance in the way in which channel-shifted market shares are calculated, these displaced wattages will not match the displaced wattages in Table 5-4 above. See discussion in Section 6.2.3 in the Impact Evaluation of 2015 Upstream and Residential Downstream Lighting Programs report.

5.4.5 Calculate delta watts after channel shift

As our final step in calculating delta watts, we subtract the average program wattage from the displaced market wattage for each channel. Table 5-6 provides these results for LED A-lamps.

Table 5-6. Delta watts by PA and channel, LED A-lamps

Channel*	Quantity of Sold Program Lamps**	Average Displaced Wattage	Average Program Discounted Wattage	Delta Watts
PG&E				
Discount	168,657	50.8	10.0	40.8
Grocery	73,254	28.7		18.7
Hardware	19,801	38.7		28.6
Home improvement	69,105	30.8		20.7
Mass merchandise	14,496	31.7		21.7
Membership club, unshifted	267,843	17.1		7.1
Membership club, channel-shifted	267,843	21.6		11.6
SCE				
Discount***	422,891	50.8	9.9	40.9
Drug	2,304	36.8		26.9
Grocery***	227,328	28.7		18.8
Hardware	100,963	38.7		28.8
Home improvement	204,355	30.8		20.8
Mass merchandise	13,900	31.7		21.8
Membership club, unshifted	463,964	17.1		7.2
Membership club, channel-shifted	463,964	21.7		11.8
SDG&E				
Discount***	39,867	50.8	14.4	36.4
Grocery***	89,438	28.7		14.3
Hardware	94,554	38.7		24.2
Home improvement	161,480	30.8		16.3
Membership club, unshifted	99,144	17.1		2.7
Membership club, channel-shifted	99,144	17.2		2.8

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
*** Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1.

5.5 Delta watts results

This section reports the results for the market level delta watts analysis that go into our calculations of unit energy savings for each measure group.

5.5.1 LED A-lamps

The average discounted wattage for LED A-lamps was about 10 watts for PG&E and SCE and 14.4 watts for SDG&E. The discount channel had the highest displaced wattage at just over 50 watts, resulting in the highest delta watts for LED A-lamps. Table 5-7 below shows the breakdown of average displaced wattage by PA and sales channel along with the corresponding average program wattage and the calculated delta watts.

Table 5-7. Delta watts results by PA and channel for LED A-lamps

Channel*	Quantity of Sold Program Lamps**	Average Displaced Wattage	Average Program Discounted Wattage	Delta Watts
PG&E				
Discount	168,657	50.8	10.0	40.8
Grocery	73,254	28.7		18.7
Hardware	19,801	38.7		28.6
Home improvement	69,105	30.8		20.7
Mass merchandise	14,496	31.7		21.7
Membership club, unshifted	267,843	17.1		7.1
Membership club, channel-shifted	267,843	21.6		11.6
SCE				
Discount***	422,891	50.8	9.9	40.9
Drug	2,304	36.8		26.9
Grocery***	227,328	28.7		18.8
Hardware	100,963	38.7		28.8
Home improvement	204,355	30.8		20.8
Mass merchandise	13,900	31.7		21.8
Membership club, unshifted	463,964	17.1		7.2
Membership club, channel-shifted	463,964	21.7		11.8
SDG&E				
Discount***	623,428	50.8	14.4	36.4
Grocery***	89,438	28.7		14.3
Hardware	94,554	38.7		24.2
Home improvement	161,480	30.8		16.3
Membership club, unshifted	99,144	17.1		2.7
Membership club, channel-shifted	99,144	17.2		2.8

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1

5.5.2 LED reflectors

The average discounted wattage for LED reflectors ranged from 7.5 watts for PG&E to 11.2 watts for SDG&E. LED reflectors tended to displace relatively high wattage alternative lamps, resulting in the highest delta watts of the upstream measures. Table 5-8 below shows the breakdown of average displaced wattage by PA and channel along with the corresponding average program wattage and the calculated delta watts.

Table 5-8. Delta watts results by PA and channel for LED reflectors

Channel*	Quantity of Sold Program Lamps**	Average Displaced Wattage	Average Program Discounted Wattage	Delta Watts
PG&E				
Discount	262,964	65.0	7.5	57.5
Grocery	304,942	59.7		52.1
Hardware	57,732	68.2		60.7
Home improvement	136,789	41.8		34.2
Mass merchandise	23,778	51.9		44.3
Membership club, unshifted	289,942	16.0		8.5
Membership club, channel-shifted	289,942	48.6		41.1
SCE				
Discount***	503,495	65.0	9.1	55.9
Drug	118,272	59.3		50.2
Grocery***	375,640	59.7		50.6
Hardware	194,912	68.2		59.1
Home improvement	365,542	41.8		32.6
Membership club, unshifted	622,441	16.0		6.9
Membership club, channel-shifted	622,441	48.6		39.5
SDG&E				
Discount***	147,462	65.0	11.2	53.8
Drug	19,828	59.3		48.2
Grocery***	64,911	59.7		48.5
Hardware	99,867	68.2		57.0
Home improvement	128,258	41.8		30.6
Membership club, unshifted	197,646	16.0		4.8
Membership club, channel-shifted	197,646	48.6		37.4

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1

5.5.3 High wattage CFLs

The average discounted wattage for high wattage CFLs ranged from 32 watts for PG&E to 37.9 watts for SCE and SDG&E. High wattage CFLs are intended to displace relatively high wattage alternative lamps, resulting in the highest delta watts of the upstream measures. However, in some channels where high wattage alternatives were not available, such as drug and membership sales channels, the average displaced wattage was actually lower than the average discounted wattage. This resulted in a negative delta watt, as the discounted measures were displacing more efficient alternatives. Table 5-9 below shows the breakdown of average displaced wattage by PA and channel along with the corresponding average program wattage and the calculated delta watts.

Table 5-9. Delta watts results by PA and channel for high wattage CFLs

Channel*	Quantity of Sold Program Lamps**	Average Displaced Wattage	Average Program Discounted Wattage	Delta Watts
PG&E				
Discount	81,000	76.4	32.0	44.4
SCE				
Discount**	439,167	76.4	37.9	38.5
Drug	5,628	15.5		(22.4)
Grocery**	255,324	79.1		41.2
Hardware	61,716	82.1		44.1
Home improvement	31,576	79.4		41.5
Mass merchandise	10,275	54.5		16.5
Membership club, unshifted	117,216	14.6		(23.3)
Membership club, channel-shifted	117,216	48.5		10.6
SDG&E				
Discount**	11,780	76.4	37.9	38.5
Grocery**	2,658	79.1		41.2
Hardware	1,200	82.1		44.2
Home improvement	5,000	79.4		41.5

*This table omits channels where the PA did not discount any high wattage CFLs.
** Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1.

5.5.4 Basic CFLs

SCE was the only program that discounted basic CFLs in 2017. The average discounted wattage for basic CFLs was 24.2 watts, and the delta watts was 45.9 for the discount channel and 12.7 for the grocery channel.

Table 5-10. Delta watts results by PA and channel for basic CFLs

Channel*	Quantity of Sold Program Lamps**	Average Displaced Wattage	Average Program Discounted Wattage	Delta Watts
SCE				
Discount***	1,800	70.1	24.2	45.9
Grocery***	3,089	36.9		12.7

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1.

5.6 HVAC interactive effects

HVAC interactive effects account for the changes in heating and cooling energy requirements due to changes in lamp wattages and efficiency. Generally, lower-wattage efficient lamps release less heat than higher-wattage, less-efficient lamps, which results in air conditioning energy savings and increased space heating requirements. DEER reports the estimated kWh, kW, and therm savings factors for indoor CFL and LED measures. In this evaluation, we applied the PA specific residential multipliers reported in DEER 2016 (Table 5-11) The same ratios apply to both CFL and LED lamps as the interactive effects vary by the wattage reduction estimate and not by lamp technology. Our evaluation team applied these savings factors to the direct impacts as a multiplier for both kWh and kW and a factor of therms per kWh for therm impacts.[36] For non-residential measures, we passed through all ex ante savings and accompanying parameters.

Table 5-11. Residential CFL and LED HVAC interactive effects factors by PA (2017 DEER)

Units	PA		
	PG&E	SCE	SDG&E
kWh	1.02	1.07	1.03
kW	1.33	1.40	1.23
Therms	-0.025	-0.019	-0.018

5.7 UES results

UES estimates are the average gross energy and peak demand impacts per measure in kWh per year and kW, respectively. Except for the changes to the delta watts calculations described previously, DNV GL calculated UES values for each of the evaluated measure groups using the same approach described in the 2010-12, 2013-14, and 2015 impact evaluations. As in the prior evaluations, this report focuses on the parameters necessary for calculating the residential UES. For measures installed in non-residential settings, we applied the approved weighted commercial UES value from PA workpapers to each non-residential measure. We show the equations for estimating the residential UES above (see Equation 5-1 and Equation 5-3). We apply the respective non-residential interactive effect factor to the UES that DEER defines for each measure.

In the sections below, we present the 2017 residential and non-residential UES results by PA and measure group for the six upstream lighting measure groups of interest for this report. Table 5-12 shows a summary table of ex ante and ex post unit energy savings for all evaluated measures.

[36] Therm impacts for upstream lighting measures are negative.

Table 5-12. 2017 Ex ante and ex post UES values by PA and measure group

PA	kWh		kW		Therms	
	Ex Ante	Ex Post	Ex Ante	Ex Post	Ex Ante	Ex Post
PG&E						
CFL high wattage (> 30 W)	26	33	0.003	0.004	-0.582	-0.661
LED A-lamp, all wattages	9	16	0.001	0.002	-0.193	-0.392
LED reflector, all wattages	15	32	0.002	0.004	-0.336	-0.756
SCE						
CFL basic spiral ≤ 30 W	11	19	0.001	0.003	-0.216	-0.350
CFL high wattage (> 30 W)	18	24	0.002	0.003	-0.337	-0.442
LED A-lamp, all wattages	9	18	0.001	0.002	-0.160	-0.338
LED reflector, all wattages	17	31	0.002	0.004	-0.312	-0.568
SDG&E						
CFL high wattage (> 30 W)	15	29	0.002	0.003	-0.228	-0.362
LED A-lamp, all wattages	8	13	0.001	0.001	-0.132	-0.227
LED reflector, all wattages	20	28	0.002	0.003	-0.309	-0.481

This table omits basic CFLs for PG&E and SCE because they did not discount any basic CFLs in their upstream lighting programs.

5.7.1 LED A-lamps

LED A-Lamp unit energy savings for kW and kWh are calculated at the channel level, as each channel has different delta watts. Therms savings are calculated by applying the interactive effects multiplier described in Section 5.6. Table 5-13 shows the unit energy savings for LED A-lamps for kWh, kW, and therms. The measure group unit energy savings are the ex post savings values that get used for gross savings calculations.

Table 5-13. Residential UES values for LED A-lamps

Channel*	Quantity of Sold Program Lamps**	kWh	kW	Therms
PG&E				
Discount	168,657	32.3	0.004	(0.771)
Grocery	73,254	14.8	0.002	(0.353)
Hardware	19,801	22.7	0.003	(0.542)
Home improvement	69,105	16.4	0.002	(0.392)
Mass merchandise	14,496	17.2	0.002	(0.410)
Membership club, unshifted	267,843	5.6	0.001	(0.134)
Membership club, shifted	267,843	17.1	0.002	(0.409)
Other	6,751	16.4	0.002	(0.392)
Measure Group UES	**887,750**	**16.4**	**0.002**	**(0.392)**
SCE				
Discount***	422,891	33.4	0.004	(0.617)
Drug	2,304	22.0	0.003	(0.406)
Grocery***	227,328	15.3	0.002	(0.284)
Hardware	100,963	23.5	0.003	(0.434)
Home improvement	204,355	17.0	0.002	(0.315)
Mass merchandise	13,900	17.8	0.002	(0.329)
Membership club, unshifted	463,964	5.9	0.001	(0.109)
Membership club, unshifted	463,964	17.7	0.002	(0.328)
Measure Group UES	**1,899,669**	**18.3**	**0.002**	**(0.338)**
SDG&E				
Discount***	39,867	28.6	0.003	(0.499)
Grocery	89,438	11.2	0.001	(0.196)
Hardware***	94,554	19.0	0.002	(0.333)
Home improvement	161,480	12.8	0.001	(0.224)
Membership club, unshifted	99,144	2.1	0.000	(0.037)
Membership club, shifted	99,144	13.5	0.002	(0.237)
Other	119,352	13.0	0.001	(0.227)
Measure Group UES	**702,979**	**13.0**	**0.001**	**(0.227)**

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
**Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1.

5.7.2 LED reflectors

LED Reflector unit energy savings for kW and kWh are calculated at the channel level, as each channel has different delta watts. Therms savings are calculated by applying the interactive effects multiplier described in Section 5.6. Table 5-14 shows the unit energy savings for LED Reflectors for kWh, kW, and therms. The measure group unit energy savings are the ex post savings values that get used for gross savings calculations.

Table 5-14. Residential UES values for LED Reflectors

Channel*	Quantity of Sold Program Lamps**	kWh	kW	Therms
PG&E				
Discount	262,964	45.6	0.006	(1.087)
Grocery	304,942	41.3	0.005	(0.986)
Hardware	57,732	48.1	0.006	(1.147)
Home improvement	136,789	27.1	0.003	(0.647)
Mass merchandise	23,778	35.2	0.004	(0.839)
Membership club, unshifted	289,942	6.7	0.001	(0.160)
Membership club, shifted	289,942	32.6	0.004	(0.777)
Other	32,544	31.7	0.004	(0.756)
Total	**1,398,633**	**31.7**	**0.004**	**(0.756)**
SCE				
Discount***	503,495	45.6	0.006	(0.844)
Drug	118,272	41.0	0.005	(0.758)
Grocery***	375,640	41.3	0.005	(0.763)
Hardware	194,912	48.2	0.006	(0.892)
Home improvement	365,542	26.6	0.003	(0.493)
Membership club, unshifted	622,441	5.6	0.001	(0.104)
Membership club, shifted	622,441	32.2	0.004	(0.596)
Total	**2,802,743**	**30.7**	**0.004**	**(0.568)**
SDG&E				
Discount***	147,462	42.3	0.005	(0.739)
Drug	19,828	37.8	0.004	(0.661)
Grocery***	64,911	38.1	0.004	(0.666)
Hardware	99,867	44.8	0.005	(0.783)
Home improvement	128,258	24.0	0.003	(0.420)
Membership club, unshifted	197,646	3.8	0.000	(0.066)
Membership club, shifted	197,646	29.4	0.003	(0.514)
Other	87,397	27.5	0.003	(0.481)
Total	**943,015**	**27.5**	**0.003**	**(0.481)**

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1.

5.7.3 High wattage CFLs

High wattage CFL unit energy savings for kW and kWh are calculated at the channel level, as each sales channel has different delta watts. Therms savings are calculated by applying the interactive effects multiplier described in Section 5.6. Table 5-15 shows the unit energy savings for high wattage CFLs for kWh, kW, and therms. The measure group unit energy savings are the ex post savings values that get used for gross savings calculations.

Table 5-15. Residential UES values for high wattage CFLs

Channel*	Quantity of Sold Program Lamps**	kWh	kW	Therms
PG&E				
Discount	81,000	32.5	0.004	(0.661)
Total	**81,000**	**32.5**	**0.004**	**(0.661)**
SCE				
Discount***	439,167	29.0	0.004	(0.540)
Drug	5,628	(16.9)	(0.002)	0.315
Grocery***	255,324	31.0	0.004	(0.578)
Hardware	61,716	33.3	0.004	(0.619)
Home improvement	31,576	31.2	0.004	(0.582)
Mass merchandise	10,275	12.5	0.002	(0.232)
Membership club, unshifted	117,216	(17.5)	(0.002)	0.326
Membership club, shifted	117,216	25.3	0.003	(0.471)
Total	**1,038,118**	**23.7**	**0.003**	**(0.442)**
SDG&E				
Discount***	11,780	27.9	0.003	(0.349)
Grocery***	2,658	29.9	0.004	(0.373)
Hardware	1,200	32.0	0.004	(0.400)
Home improvement	5,000	30.1	0.004	(0.376)
Other	3,180	29.0	0.003	(0.362)
Total	**23,818**	**29.0**	**0.003**	**(0.362)**

*This table has omitted channels where the PA did not discount any LED A-lamps
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1

5.7.4 Basic CFLs

Basic CFL unit energy savings for kW and kWh are calculated at the channel level, as each channel have different delta watts. Therms savings are calculated by applying the interactive effects multiplier described in Section 5.6. Table 5-16 shows the unit energy savings for basic CFL for kWh, kW, and therms. The measure group unit energy savings are the ex post savings values that get used for gross savings calculations.

Table 5-16. Residential UES values for basic CFLs

Channel[1]	Quantity of Sold Program Lamps	kWh	kW	Therms
SCE				
Discount	1,800	34.8	0.005	(0.644)
Grocery	3,089	9.6	0.001	(0.178)
Total	**4,889**	**18.9**	**0.003**	**(0.350)**

This table omits channels where the PA did not discount any LED A-lamps.

6 NET SAVINGS ANALYSIS

Section 6.1 describes how the evaluation team developed 2017 program year NTGRs. We demonstrate each step using the LED A-lamp measure group as an example. This particular measure group provides a useful demonstration of our approach because the program had discounted LED A-lamps available in all channels during 2017, and the impacts of channel shift are very clear. This example provides the details necessary to calculate net savings for this particular measure group. Section 6.2 presents the results for all measure groups, including LED A-lamps.

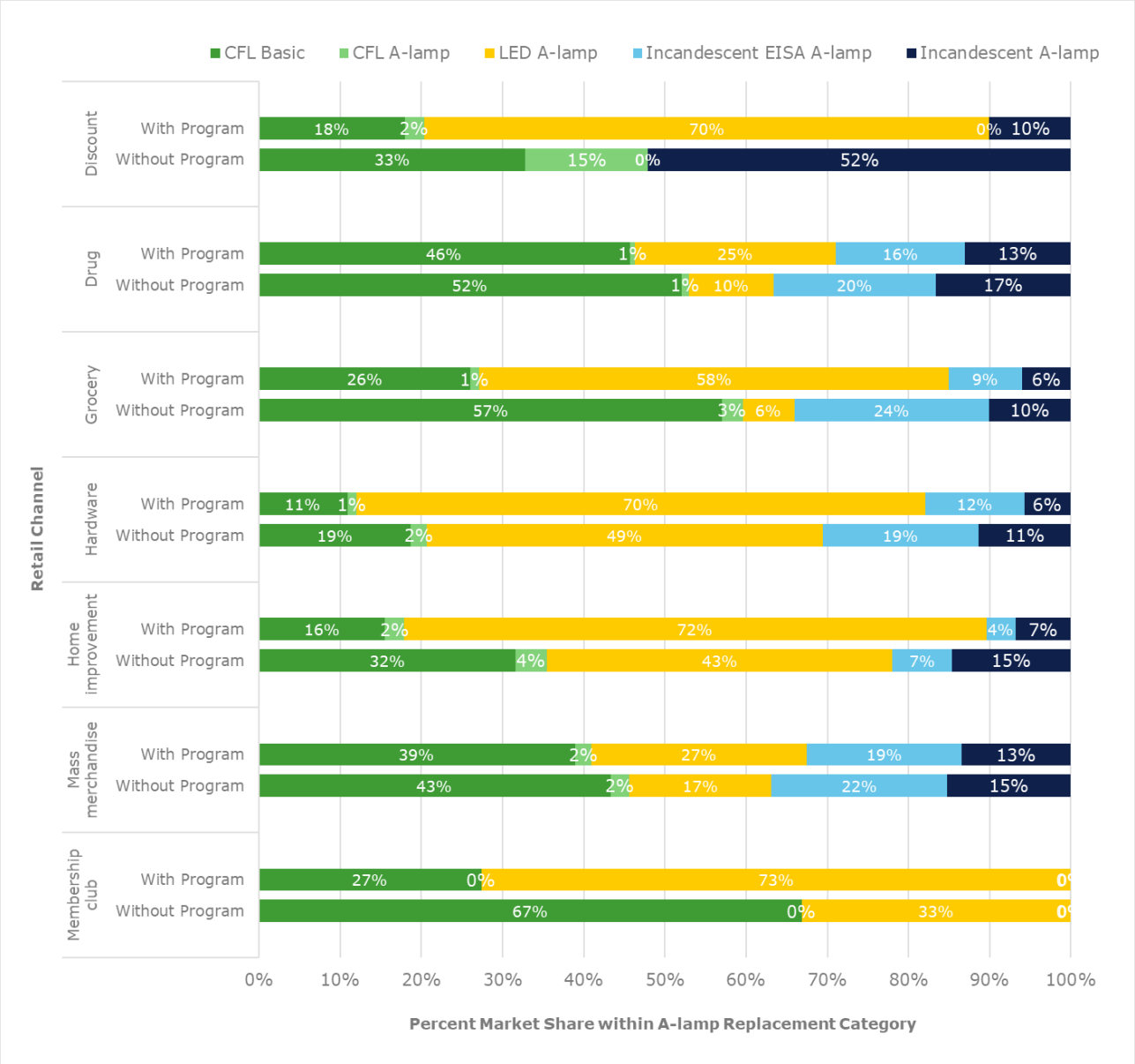
6.1 NTGR methodology with A-lamp example

The NTGR is the proportion of all program lamp purchases that are program-attributable. Program-attributable lamps are defined as lamp purchases of a given technology for which customers would have purchased a different technology in the absence of the program.

6.1.1 Market shares

To calculate the NTGR, we leverage the Lamp Choice Model market shares, as discussed in Section 3.8. We calculate market shares with and without program discounts for the same purchase instances. The NTGR is equal to the percentage of program-discounted lamps that displaced purchases of other technologies. Figure 6-1 presents the market share results when program discounts for LED A-lamps were available and when they were not. For example, in home improvement stores with program discounts available, LED A-lamps had 72% market share in the A-lamp replacement category. When we removed the program effects from those simulations, LED A-lamps had 43% market share in that channel.

Figure 6-1. LED A-lamp Lamp Choice Model results



6.1.2 NTGR

As noted above, we used these market share estimates to calculate the percent of program-discounted lamps that were attributable to the program. Equation 6-1 presents the equation for calculating the NTGR.[37]

Equation 6-1. NTGR for lamp group L and channel C

$$NTGR_{L,C} = 1 - \frac{MS_{L,C,0}}{MS_{L,C,p}}$$

[37] This formula is the same as the formula used for the NTGRq in the 2015 evaluation.

Where:

$NTGR_{L,C}$ = Net-to-Gross Ratio for measure group L, in chancel C

$MS_{L,C,0}$ = Market share of the lamp measure group L, in channel C, without program discounts

$MS_{L,C,p}$ = Market share of the lamp measure group L, in channel C, with program discounts

As indicated in the equation, the proportion of program lamp purchases that would have been the same technology without the program is the ratio of without-program to with-program shares. One minus this ratio is the program-attributable proportion of program lamp purchases.

Table 6-1 shows the Lamp Choice Model's A-lamp market shares with and without LED A-lamp program discounts, along with the NTGRs by retail channel. Within the home improvement channel, for example, 43% (without-program estimate) divided by 72% (with-program estimate) yields 59%. This means that 59% of the purchased program-discounted LED A-lamps in home improvement stores would have been LED purchases even without program incentives. We subtract 59% from 1 to yield 41%. This is the percent of the purchases of program-discounted LED A-lamps in home improvement stores that would *not* have been LED lamps in absence of the program.[38] Thus, 41% is the program-attributable proportion of LED purchases, and this is the NTGR.

Table 6-1. LED A-lamp Lamp Choice Model results and NTGRs by channel

Channel	Market Share		NTGR
	With Program	Without Program	
Discount	70%	0%	100%
Drug	25%	10%	58%
Grocery	58%	6%	89%
Hardware	70%	49%	30%
Home improvement	72%	43%	41%
Mass merchandise	27%	17%	34%
Membership club	73%	33%	54%

6.1.3 Account for channel shift in membership club stores

In the 2015 upstream and residential impact evaluation, we developed a methodology with an assumption that program lamps sold within membership club stores likely shifted lamp sales out of the rest of the market. Interviews with lamp suppliers indicated that program lamps sold within membership club stores often were sales of the same technology shifted from other channels. This channel shift did not appear to be a major issue for other channels. We used this same methodology in this evaluation. Based on supplier interviews, we calculated that in the absence of the program 50% of membership club program lamps would have been purchases across the rest of the market. For these 50% of "channel-shifted" program lamps, we calculated the NTGRs as an average of the other channels' NTGRs, weighted by the percentage of purchases

[38] Note that the Net-to-Gross Ratio accounts for program-reliant lamps. For cases in which no program-discounted lamps within a specific evaluated upstream lighting measure group would have been available in absence of the program, the Net-to-Gross Ratio is 100% (as is the case for LED A-lamps in the discount channel).

shifted from each other channel. We calculated a channel-shifted NTGR for each PA and measure group. See Section 6.2.3 in the 2015 impact evaluation report for a full demonstration of this methodology.[39]

6.1.4 Overall NTGR

We calculate an overall NTGR for each PA and measure group by weighting each channel's NTGR by the product of the quantity of lamps that the program shipped to the channel and the market UES for that channel and PA. Note that because the UES values are specific to each channel, we need to account for them in the weighting, and cannot simply weight by quantity of lamps that the program shipped to each channel. Equivalent to this weighting are the following steps for each PA: for each channel we multiply the channel UES by the channel volume to determine channel total gross savings. We then multiply by channel NTGR to determine channel net savings. We sum total net and total gross savings across channels. The ratio of these totals is the NTGR.

Table 6-2 below provides the NTGR results for LED A-Lamps. Within this example, we note that the discount and grocery store channels have the highest NTGRs (100% and 89%, respectively). Hardware, home improvement, and mass merchandise have the lowest NTGRs (30%, 34%, and 41%, respectively). Discount and grocery stores generally have lower diversity of lamp stock, and a higher dependency on program discounts to stock the efficient lamps, while hardware, home improvement, and mass merchandise stores more readily carry the most efficient lamps at relatively competitive prices.[40] This results in higher NTGRs for discount and grocery stores compared to hardware, home improvement, and mass merchandise stores.

While the same NTGRs for a given channel are applied to all the PAs, the different mix of program sales across channels results in different overall NTGRs among the three PAs. PG&E (86%) and SCE (84%) both have favorable NTGRs while SDG&E has a lower NTGR of 64%. While SCE and SDG&E shipped the majority of their LED A-lamps to discount and grocery stores, we have adjusted these quantities to reflect quantities that these channels could support selling (see Section 4.1). Therefore, PG&E and SCE's higher NTGRs are largely driven by the membership club store NTGRs (both the un-shifted and the channel-shifted). Outside of the discount and grocery store channels, SDG&E shipped lamps relatively evenly across the remaining channels.

When interpreting the results in Section 6.2 below, we will review the quantities of lamps that programs shipped to stores (adjusted by sales-to-shipment rates), as well as each channel's respective UES and NTGR values, and the effect that these variables collectively have on the overall NTGR for each measure group and PA.

[39] DNV GL 2017b.
[40] DNV GL 2019.

Table 6-2. LED A-lamp NTGR results

Channel*	Count of Sold Lamps**	Unit Energy Savings (kWh)	Unit Energy Savings (kW)	Unit Energy Savings (Therms)	NTGR***
PG&E					
Discount	168,657	32.3	0.004	(0.771)	100%
Grocery	73,254	14.8	0.002	(0.353)	89%
Hardware	19,801	22.7	0.003	(0.542)	30%
Home improvement	69,105	16.4	0.002	(0.392)	41%
Mass merchandise	14,496	17.2	0.002	(0.410)	34%
Membership club, unshifted	267,843	5.6	0.001	(0.134)	54%
Membership club, shifted	267,843	17.1	0.002	(0.409)	100%
Other	6,751	16.4	0.002	(0.392)	86%
Total	**887,750**	**16.4**	**0.002**	**(0.392)**	**86%**
SCE					
Discount****	422,891	33.4	0.004	(0.617)	100%
Drug	2,304	22.0	0.003	(0.406)	58%
Grocery****	227,328	15.3	0.002	(0.284)	89%
Hardware	100,963	23.5	0.003	(0.434)	30%
Home improvement	204,355	17.0	0.002	(0.315)	41%
Mass merchandise	13,900	17.8	0.002	(0.329)	34%
Membership club, unshifted	463,964	5.9	0.001	(0.109)	54%
Membership club, shifted	463,964	17.7	0.002	(0.328)	100%
Total	**1,899,669**	**18.3**	**0.002**	**(0.338)**	**84%**
SDG&E					
Discount****	39,867	28.6	0.003	(0.499)	100%
Grocery	89,438	11.2	0.001	(0.196)	89%
Hardware****	94,554	19.0	0.002	(0.333)	30%
Home improvement	161,480	12.8	0.001	(0.224)	41%
Membership club, unshifted	99,144	2.1	0.000	(0.037)	54%
Membership club, shifted	99,144	13.5	0.002	(0.237)	100%
Other	119,352	13.0	0.001	(0.227)	64%
Total	**702,979**	**13.0**	**0.001**	**(0.227)**	**64%**

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Each PA's overall NTGR is the weighted average of cross-PA channel-level NTGRs. The weight for each channel is the product of the channel's unit energy savings and its count of sold lamps.
****Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1

6.2 NTGR results

This section provides the NTGRs for each measure group by PA. For each measure group, we present the channel-level detail for the count of lamps sold, the UES values, and the NTGRs. The full derivation of the channel-level UES and NTGRs can be found in Appendix F.

6.2.1 LED A-lamps

For LED A-lamps, as stated in the example in Section 6.1.4, PG&E (86%) and SCE (84%) both have favorable NTGRs, while SDG&E has a lower NTGR of 64% (see Table 6-3). Note that the discount and grocery store channels have the highest NTGRs (100% and 89% respectively). Hardware, home improvement, and mass merchandise have the lowest NTGRs (30%, 34%, and 41% respectively).

As discussed in Section 6.1.4, the variations in PA-level net-to-gross ratios reflect different mixes of the number of lamps sold by channel.

Table 6-3. LED A-lamp NTGR results

Channel*	Count of Sold Lamps**	Unit Energy Savings (kWh)	Unit Energy Savings (kW)	Unit Energy Savings (Therms)	NTGR***
PG&E					
Discount	168,657	32.3	0.004	(0.771)	100%
Grocery	73,254	14.8	0.002	(0.353)	89%
Hardware	19,801	22.7	0.003	(0.542)	30%
Home improvement	69,105	16.4	0.002	(0.392)	41%
Mass merchandise	14,496	17.2	0.002	(0.410)	34%
Membership club, unshifted	267,843	5.6	0.001	(0.134)	54%
Membership club shifted	267,843	17.1	0.002	(0.409)	100%
Other	6,751	16.4	0.002	(0.392)	86%
Total	**887,750**	**16.4**	**0.002**	**(0.392)**	**86%**
SCE					
Discount****	422,891	33.4	0.004	(0.617)	100%
Drug	2,304	22.0	0.003	(0.406)	58%
Grocery****	227,328	15.3	0.002	(0.284)	89%
Hardware	100,963	23.5	0.003	(0.434)	30%
Home improvement	204,355	17.0	0.002	(0.315)	41%
Mass merchandise	13,900	17.8	0.002	(0.329)	34%
Membership club, unshifted	463,964	5.9	0.001	(0.109)	54%
Membership club, shifted	463,964	17.7	0.002	(0.328)	100%
Total	**1,899,669**	**18.3**	**0.002**	**(0.338)**	**84%**
SDG&E					
Discount****	39,867	28.6	0.003	(0.499)	100%
Grocery	89,438	11.2	0.001	(0.196)	89%
Hardware****	94,554	19.0	0.002	(0.333)	30%
Home improvement	161,480	12.8	0.001	(0.224)	41%
Membership club, unshifted	99,144	2.1	0.000	(0.037)	54%
Membership club, shifted	99,144	13.5	0.002	(0.237)	100%
Other	119,352	13.0	0.001	(0.227)	64%
Total	**702,979**	**13.0**	**0.001**	**(0.227)**	**64%**

*This table omits channels where the PA did not discount any LED A-lamps.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Each PA's overall NTGR is the weighted average of cross-PA channel-level NTGRs. The weight for each channel is the product of the channel's unit energy savings and its count of sold lamps.
****Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1.

6.2.2 LED reflectors

For LED Reflectors, all PAs have relatively favorable NTGRs: PG&E with 81%, SCE with 77%, and SDG&E with 71% (see Table 6-4). For this measure group, the discount, drug, grocery, and membership club stores shifted from other channels all show high NTGRs.

PG&E's shipments to discount, grocery, and membership club stores (for channel shifted lamps) weighted the overall NTGR high. After we applied the sales-to-shipment ratio to SCE's quantities, their overall NTGR benefited from high grocery, drug, discount, and membership club channel-shifted NTGRs, while the low hardware, home improvement, and membership club unshifted NTGRs pushed the overall NTGRs down to 77%. SDG&E's sales quantities are similar to SCE, except their discount store sales were substantially larger than their drug and grocery sales.

Table 6-4. LED reflectors NTGR results

Channel*	Count of Sold Lamps**	Unit Energy Savings (kWh)	Unit Energy Savings (kW)	Unit Energy Savings (Therms)	NTGR***
PG&E					
Discount	262,964	45.6	0.006	(1.087)	100%
Grocery	304,942	41.3	0.005	(0.986)	100%
Hardware	57,732	48.1	0.006	(1.147)	31%
Home improvement	136,789	27.1	0.003	(0.647)	37%
Mass merchandise	23,778	35.2	0.004	(0.839)	33%
Membership club, unshifted	289,942	6.7	0.001	(0.160)	29%
Membership club, shifted	289,942	32.6	0.004	(0.777)	76%
Other	32,544	31.7	0.004	(0.756)	81%
Total	**1,398,633**	**31.7**	**0.004**	**(0.756)**	**81%**
SCE					
Discount****	503,495	45.6	0.006	(0.844)	100%
Drug	118,272	41.0	0.005	(0.758)	100%
Grocery****	375,640	41.3	0.005	(0.763)	100%
Hardware	194,912	48.2	0.006	(0.892)	31%
Home improvement	365,542	26.6	0.003	(0.493)	37%
Membership club, unshifted	622,441	5.6	0.001	(0.104)	29%
Membership club, shifted	622,441	32.2	0.004	(0.596)	76%
Total	**2,802,743**	**30.7**	**0.004**	**(0.568)**	**77%**
SDG&E					
Discount****	147,462	42.3	0.005	(0.739)	100%
Drug	19,828	37.8	0.004	(0.661)	100%
Grocery****	64,911	38.1	0.004	(0.666)	100%
Hardware	99,867	44.8	0.005	(0.783)	31%
Home improvement	128,258	24.0	0.003	(0.420)	37%
Membership club, unshifted	197,646	3.8	0.000	(0.066)	29%
Membership club, shifted	197,646	29.4	0.003	(0.514)	76%
Other	87,397	27.5	0.003	(0.481)	71%
Total	**943,015**	**27.5**	**0.003**	**(0.481)**	**71%**

*This table omits channels where the PA did not discount any LED reflectors.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Each PA's overall NTGR is the weighted average of cross-PA channel-level NTGRs. The weight for each channel is the product of the channel's unit energy savings and its count of sold lamps.
****Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1

6.2.3 High wattage CFLs

As shown in Table 6-5, high wattage CFL NTGRs were low across all PAs. SCE had the highest NTGR at 46%, SDG&E had a slightly lower NTGR of 31%, and PG&E had the lowest NTGR at 17%. Both PG&E and SDG&E discounted a relatively small quantity of high wattage CFLs, and the sales-to-shipment ratio further reduced SCE's and SDG&E's shipments to discount and grocery stores. Even with the sales-to-shipment quantity reduction, SCE sold over 1,000,000 high wattage CFLs, mostly through discount and grocery stores. This is more in line with the market capacity for high wattage CFLs according to the CREED sales data. While high wattage CFLs provided a niche offering for efficient high-brightness lamps, these results suggest that many customers who purchase these lamps would do so without program discounts.

Table 6-5. High wattage CFL NTGR results

Channel*	Count of Sold Lamps**	Unit Energy Savings (kWh)	Unit Energy Savings (kW)	Unit Energy Savings (Therms)	NTGR***
PG&E					
Discount	81,000	32.5	0.004	(0.661)	17%
Total	**81,000**	**32.5**	**0.004**	**(0.661)**	**17%**
SCE					
Discount****	439,167	29.0	0.004	(0.540)	17%
Drug	5,628	(16.9)	(0.002)	0.315	0%
Grocery****	255,324	31.0	0.004	(0.578)	78%
Hardware	61,716	33.3	0.004	(0.619)	66%
Home improvement	31,576	31.2	0.004	(0.582)	27%
Mass merchandise	10,275	12.5	0.002	(0.232)	38%
Membership club, unshifted	117,216	(17.5)	(0.002)	0.326	0%
Membership club, shifted	117,216	25.3	0.003	(0.471)	52%
Total	**1,038,118**	**23.7**	**0.003**	**(0.442)**	**47%**
SDG&E	11,780	27.9	0.003	(0.349)	17%
Discount****	11,780	27.9	0.003	(0.349)	17%
Grocery	2,658	29.9	0.004	(0.373)	78%
Hardware****	1,200	32.0	0.004	(0.400)	66%
Home improvement	5,000	30.1	0.004	(0.376)	27%
Other	3,180	29.0	0.003	(0.362)	31%
Total	**23,818**	**29.0**	**0.003**	**(0.362)**	**31%**

*This table omits channels where the PA did not discount any high wattage CFLs.
**The count of sold lamps is the program shipments, adjusted where applicable by the sales-to-shipment ratio, per Section 4.1.
***Each PA's overall NTGR is the weighted average of cross-PA channel-level NTGRs. The weight for each channel is the product of the channel's unit energy savings and its count of sold lamps.
****Sales-to-shipment quantity adjustments are applied to this channel for this PA, as described in Section 4.1

6.2.4 Basic CFLs

SCE was the only PA to offer basic CFLs as part of their 2017 portfolio, of which they only shipped 5,000. As mentioned in Section 4.1, we did not apply the sales-to-shipment ratio to basic CFLs as the total quantity of basic CFLs in the program was too small to indicate an oversaturation of the lighting market in these channels. Nevertheless, our net-to-gross findings reveal that this measure was so mainstream in 2017 that they only achieved an overall NTGR of 17% (see Table 6-6). This suggests that 83% of upstream program basic CFLs would have sold without program discounts.

Table 6-6. Basic CFL NTGR results

Channel*	Count of Sold Lamps	Unit Energy Savings (kWh)	Unit Energy Savings (kW)	Unit Energy Savings (Therms)	NTGR**
SCE					
Discount	1,800	34.8	0.005	(0.644)	24%
Grocery	3,089	9.6	0.001	(0.178)	2%
Total	**4,889**	**18.9**	**0.003**	**(0.350)**	**17%**

*This table omits channels where the PA did not discount any basic CFLs.
**Note we calculate the overall net-to-gross as a weighted average. The weight for each channel is the product of the channel's respective unit energy savings measurement and its program lamp quantity

7 EVALUATION RESULTS

In this section, we provide gross savings and net savings results by PA.

7.1 Gross savings results

This section presents the total gross savings results by measure group and PA. The methodology for calculating gross savings is described in Section 5. Gross realization rates are the ratio of ex post evaluated savings to the ex ante savings assumptions. Upstream lighting measures generally had ex post gross unit energy savings that exceeded ex ante assumptions. However, the sales-to-shipment quantity adjustment described in section 4.1 reduced overall gross savings. Below we show overall gross savings results for the evaluated measures as well as a breakdown by each PA.

7.1.1 Overall

Table 7-1 provides statewide gross realization rates for each evaluated measure group by kWh, kW, and therms. Overall the upstream and residential downstream measures achieved a 60% gross realization rate for kWh, 60% for kW, and 70% for therms. Basic CFLs had the highest gross realization rates because there was not a shipment-to-sales quantity adjustment applied to that measure group. High wattage CFLs, LED A-lamps and LED reflectors all have low gross realization rates due to the sales-to-shipment ratio. High wattage CFLs had the lowest gross realization rates as the gross unit energy savings was closer to the ex ante unit energy savings (Table 7-1). The LED measures performed better at the unit energy savings level, resulting in gross realization rates in the 60-82% range statewide.

Table 7-1. Ex ante and ex post gross savings and gross realization rates by measure group across all PAs, 2017

Evaluated Upstream Lighting Measure Group	Ex Ante			Ex Post			Gross Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL basic spiral ≤ 30 W	72,120	10	-1,162	97,670	16	-1,538	135%	157%	132%
CFL high wattage (> 30 W)	72,258,803	9,870	-1,190,447	27,291,182	3,858	-470,670	38%	39%	40%
LED A-lamp, all wattages	85,180,268	12,048	-1,303,191	58,771,946	8,087	-1,064,076	69%	67%	82%
LED reflector, all wattages	268,967,123	38,688	-4,028,548	162,183,885	22,878	-2,897,962	60%	59%	72%
Pass-through measures	24,441,313	3,625	-366,540	24,441,313	3,625	-366,540	100%	100%	100%
Overall	**450,919,628**	**64,241**	**-6,889,888**	**272,785,996**	**38,465**	**-4,800,788**	**60%**	**60%**	**70%**

Table 7-2 shows a breakdown of statewide ex post results split into residential and non-residential gross savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-2. Ex post gross savings by lighting measure group and sector across all PAs, 2017

Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL basic spiral ≤ 30 W	82,478	15,192	11	5	-1,526	-12
CFL high wattage (> 30 W)	24,876,848	2,414,335	3,129	728	-463,696	-6,974
LED A-lamp, all wattages	52,983,669	5,788,277	6,486	1,602	-1,043,472	-20,605
LED reflector, all wattages	142,558,926	19,624,959	17,442	5,436	-2,830,270	-67,693
Pass-through measures	18,317,415	6,123,898	2,115	1,510	-339,104	-27,437
Overall	**238,819,335**	**33,966,661**	**29,184**	**9,280**	**-4,678,067**	**-122,720**

7.1.2 PG&E

PG&E gross realization rates are presented in Table 7-3. There was not a sales-to-shipment quantity adjustment applied to the PG&E program. As such, gross realization rates were in the 152-206% range for evaluated measures. This high gross realization rates are a result of the difference between the ex ante and ex post baseline for upstream measures. The LED A-lamp and LED reflector measure groups had the highest gross realization rates.

Table 7-3. PG&E ex ante and ex post gross savings and gross realization rates by lighting measure group, 2017

Measure Group	Ex Ante			Ex Post			Gross Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL high wattage (> 30 W)	1,994,899	317	-34,018	3,101,298	481	-52,356	155%	152%	154%
LED A-lamp, all wattages	8,681,214	1,253	-164,370	15,396,569	2,158	-331,219	177%	172%	202%
LED reflector, all wattages	25,908,002	3,753	-488,871	46,722,353	6,547	-1,004,690	180%	174%	206%
Pass-through measures	12,947,463	1,795	-236,003	12,947,463	1,795	-236,003	100%	100%	100%
Overall	**49,531,577**	**7,119**	**-923,262**	**78,167,682**	**10,982**	**-1,624,268**	**158%**	**154%**	**176%**

This table omits the basic CFLs measure group because PG&E did not discount any basic CFLs in their 2017 upstream program.

Table 7-4 shows a breakdown of PG&E ex post results split into residential and non-residential gross savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-4. PG&E ex post gross savings by evaluated upstream lighting measure group and sector, 2017

Evaluated Upstream Lighting Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL high wattage (> 30 W)	2,327,286	774,012	297	184	-47,306	-5,050
LED A-lamp, all wattages	13,290,476	2,106,093	1,662	496	-316,927	-14,293
LED reflector, all wattages	40,409,782	6,312,571	5,054	1,493	-963,618	-41,072
Pass-through measures	10,741,843	2,205,619	1,272	523	-221,675	-14,328
Overall	**66,769,387**	**11,398,295**	**8,285**	**2,696**	**-1,549,525**	**-74,742**

This table omits the basic CFLs measure group because PG&E did not discount any Basic CFLs in their 2017 upstream program.

7.1.3 SCE

SCE gross realization rates are presented in Table 7-5. As explained in Section 4.1, SCE focused a large portion of their program on the discount and grocery channels. This evaluation applied a significant adjustment to the quantity of measures that received savings credit within those channels. As such, the measures that were affected by the quantity adjustment achieved a lower gross realization rate.

Table 7-5. SCE ex ante and ex post gross savings and gross realization rates by measure group, 2017

Measure Group	Ex Ante			Ex Post			Gross Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL basic spiral ≤ 30 W	72,120	10	-1,162	97,670	16	-1,538	135%	157%	132%
CFL high wattage (> 30 W)	63,981,147	8,572	-1,082,248	23,609,754	3,300	-411,546	37%	39%	38%
LED A-lamp, all wattages	43,899,998	6,184	-711,073	34,241,753	4,674	-593,593	78%	76%	83%
LED reflector, all wattages	130,331,253	18,996	-2,063,198	87,634,021	12,473	-1,474,594	67%	66%	71%
Pass-through measures	22,444,867	708	-129,698	22,444,867	708	-129,698	100%	100%	100%
Overall	**260,729,385**	**34,469**	**-3,987,378**	**168,028,066**	**21,171**	**-2,610,968**	**64%**	**61%**	**65%**

Table 7-6 shows a breakdown of SCE ex post results split into residential and non-residential gross savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-6. SCE ex post gross energy savings by measure group and sector, 2017

Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL basic spiral ≤ 30 W	82,478	15,192	11	5	-1,526	-12
CFL high wattage (> 30 W)	22,012,092	1,597,663	2,769	531	-409,681	-1,865
LED A-lamp, all wattages	31,952,522	2,289,231	3,934	740	-591,271	-2,322
LED reflector, all wattages	79,227,957	8,406,064	9,754	2,719	-1,466,087	-8,506
Pass-through measures	22,444,867	0	708	0	-129,698	0
Overall	**155,719,916**	**12,308,150**	**17,176**	**3,995**	**-2,598,264**	**-12,705**

7.1.4 SDG&E

Similar to the results for SCE, SDG&E had low gross realization rates largely due to the sales-to-shipment quantity adjustment described in section 4.1. LED measures had higher gross realization rates than the high wattage CFLs because of higher gross savings at the unit energy savings when compared to ex ante savings assumptions. SDG&E gross realization rates are presented in Table 7-7.

Table 7-7. SDG&E ex ante and ex post gross savings and gross realization rates by measure group, 2017

Measure Group	Ex Ante			Ex Post			Gross Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL high wattage (> 30 W)	6,282,757	981	-74,181	580,130	76	-6,769	9%	8%	9%
LED A-lamp, all wattages	32,599,057	4,611	-427,748	9,133,625	1,255	-139,265	28%	27%	33%
LED reflector, all wattages	112,727,868	15,938	-1,476,479	27,827,511	3,859	-418,678	25%	24%	28%
Pass-through measures	22,474,713	2,536	-212,366	22,474,713	2,536	-212,366	100%	100%	100%
Overall	**174,084,396**	**24,066**	**-2,190,774**	**60,015,979**	**7,726**	**-777,077**	**34%**	**32%**	**35%**

This table omits the basic CFLs measure group because SDG&E did not discount any basic CFLs in their 2017 upstream program.

Table 7-8 shows a breakdown of SDG&E ex post results split into residential and non-residential gross savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-8. SDG&E ex post gross savings by measure group and sector, 2017

Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL high wattage (> 30 W)	537,470	42,660	63	13	-6,709	-60
LED A-lamp, all wattages	7,740,671	1,392,954	890	365	-135,274	-3,991
LED reflector, all wattages	22,921,187	4,906,324	2,635	1,224	-400,564	-18,114
Pass-through measures	18,556,435	3,918,278	1,549	987	-199,257	-13,109
Overall	**49,755,763**	**10,260,216**	**5,137**	**2,589**	**-741,804**	**-35,273**

This table has omitted the basic CFLs measure group because SDG&E did not discount any basic CFLs in their 2017 upstream program.

7.2 Net savings results

This section presents the total net savings results by measure group and PA. PG&E's upstream and residential downstream lighting LED measure groups achieved net realized rates well above 100%, while high wattage CFLs achieved 54% net realization rates. SCE and SDG&E's upstream and residential downstream lighting portfolios achieved lower net savings results for most measures due in large part to the fact that the lighting market was not able to sell the quantities of lamps that the program discounted.

7.2.1 Overall

Overall, the upstream and residential downstream lighting program net realization rates were low. This is due primarily to the low net realization rates for SCE and SDG&E's programs, and the fact that their share of the overall statewide savings is high. Table 7-9 shows that high wattage CFLs delivered the lowest net realization rates at 20% for kWh, 22% for kW, and 19% for therms. LED A-lamps achieved the highest net realization rate at 73% for kWh, 70% for kW, and 91% for therms.

Table 7-9. Ex ante and ex post net savings and realization rates by measure group across all PAs, 2017

Measure Group	Ex Ante			Ex Post			Net Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL basic spiral ≤ 30 W	62,562	9	-1,000	26,798	6	-267	43%	68%	27%
CFL high wattage (> 30 W)	64,598,050	8,742	-1,072,750	12,691,400	1,930	-206,550	20%	22%	19%
LED A-lamp, all wattages	64,444,115	9,203	-963,458	47,273,295	6,406	-872,233	73%	70%	91%
LED reflector, all wattages	232,500,105	33,634	-3,441,573	125,511,056	17,782	-2,243,980	54%	53%	65%
Pass-through measures	39,335,475	3,313	-381,849	39,335,475	3,313	-381,849	100%	100%	100%
Overall	**400,940,307**	**54,901**	**-5,860,630**	**224,838,023**	**29,437**	**-3,704,879**	**56%**	**54%**	**63%**

Table 7-10 shows a breakdown of statewide ex post results split into residential and non-residential net savings. We explain how the residential and non-residential split is calculated and applied in for the evaluated upstream measures section 4.2.

Table 7-10. Ex post net savings by measure group and sector across all PAs, 2017

Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL basic spiral ≤ 30 W	13,884	12,913	2	4	-257	-10
CFL high wattage (> 30 W)	10,881,897	1,809,503	1,368	561	-202,198	-4,352
LED A-lamp, all wattages	43,338,066	3,935,228	5,317	1,089	-858,205	-14,028
LED reflector, all wattages	109,765,648	15,745,408	13,445	4,337	-2,188,480	-55,500
Pass-through measures	35,336,283	3,999,192	2,327	986	-363,947	-17,902
Overall	**199,335,778**	**25,502,244**	**22,459**	**6,978**	**-3,613,086**	**-91,793**

7.2.2 PG&E

We present PG&E net realization rates in Table 7-11. While PG&E's high wattage CFLs, only achieved 49% kWh, 61% kW, and 35% therms realization rates, their LED A-lamps and LED reflector lamps achieved net realization rates over 100%. This is due to evidence that the ex ante unit energy savings was too efficient. PG&E's lighting portfolio achieved overall 155% kWh, 151% kW, and 174% therms net realization rates.

Table 7-11. PG&E ex ante and ex post net savings and realization rates by measure group, 2017

Evaluated Upstream Lighting Measure Group	Ex Ante			Ex Post			Net Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL high wattage (> 30 W)	1,656,316	245	-30,759	816,326	150	-10,824	49%	61%	35%
LED A-lamp, all wattages	6,046,592	880	-113,514	12,923,491	1,775	-283,769	214%	202%	250%
LED reflector, all wattages	22,586,683	3,281	-425,216	37,735,541	5,295	-810,278	167%	161%	191%
Pass-through measures	8,250,036	1,148	-149,746	8,250,036	1,148	-149,746	100%	100%	100%
Overall	**38,539,627**	**5,553**	**-719,235**	**59,725,394**	**8,368**	**-1,254,616**	**155%**	**151%**	**174%**

This table omits the basic CFLs measure group because PG&E did not discount any basic CFLs in their 2017 upstream program.

Table 7-12 shows a breakdown of PG&E ex post results split into residential and non-residential net savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-12. PG&E ex post net savings by measure group and sector, 2017

Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL high wattage (> 30 W)	398,360	417,966	51	99	-8,097	-2,727
LED A-lamp, all wattages	11,491,009	1,432,482	1,437	338	-274,016	-9,752
LED reflector, all wattages	32,569,541	5,166,001	4,073	1,222	-776,658	-33,620
Pass-through measures	6,816,410	1,433,625	808	340	-140,433	-9,312
Overall	**51,275,320**	**8,450,075**	**6,369**	**1,999**	**-1,199,205**	**-55,411**

This table omits the basic CFLs measure group because PG&E did not discount any basic CFLs in their 2017 upstream program.

7.2.3 SCE

We present SCE net realization rates in Table 7-13. SCE's high wattage CFLs achieved 20% kWh, 23% kW, and 20% therms realization rates, and basic CFLs 43% kWh, 68% kW, and 27% therms net realization rates. Both of these measure groups had low NTGRs. We reduced high wattage CFLs quantities to reflect what the market actually sold. While we also adjusted LED reflector lamps and LED A-lamps using the sales-to-shipment ratio, the high unit energy savings bring their net kWh realization rates to 65% and 98%, respectively.

Table 7-13. SCE ex ante and ex post net savings and realization rates by measure group, 2017

Measure Group	Ex Ante			Ex Post			Net Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL basic spiral ≤ 30 W	62,562	9	-1,000	26,798	6	-267	43%	68%	27%
CFL high wattage (> 30 W)	57,583,032	7,714	-974,023	11,675,908	1,749	-193,618	20%	23%	20%
LED A-lamp, all wattages	29,087,525	4,170	-465,928	28,405,700	3,807	-498,623	98%	91%	107%
LED reflector, all wattages	104,217,264	15,401	-1,632,906	67,424,771	9,589	-1,135,295	65%	62%	70%
Pass-through measures	16,792,633	529	-97,800	16,792,633	529	-97,800	100%	100%	100%
Overall	**207,743,016**	**27,823**	**-3,171,658**	**124,325,810**	**15,680**	**-1,925,604**	**60%**	**56%**	**61%**

Table 7-14 shows a breakdown of SCE ex post results split into residential and non-residential net savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-14. SCE ex post net savings by evaluated upstream lighting measure group and sector, 2017

Evaluated Upstream Lighting Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL basic spiral ≤ 30 W	13,884	12,913	2	4	-257	-10
CFL high wattage (> 30 W)	10,317,895	1,358,013	1,298	452	-192,033	-1,585
LED A-lamp, all wattages	26,860,333	1,545,367	3,307	500	-497,042	-1,582
LED reflector, all wattages	60,997,828	6,426,943	7,510	2,079	-1,128,745	-6,551
Pass-through measures	16,792,633	0	529	0	-97,800	0
Overall	**114,982,573**	**9,343,237**	**12,645**	**3,035**	**-1,915,877**	**-9,727**

7.2.4 SDG&E

We present SDG&E's net realization rates in Table 7-15. SDG&E's high wattage CFLs achieved 4% kWh, 4% kW, and 3% therms realization rates. LED reflectors and LED A-lamps achieved between 19% and 23% net realization rates. SDG&E's net realization rates were lower than PG&E's and SDG&E's primarily because discount and grocery store managers estimated that they sold between 5% and 6% of the quantities referenced in the tracking data. SDG&E's program was dominated by large shipments to discount and grocery stores, and therefore this adjustment had a large impact on their program-level net realization rates.

Table 7-15. SDG&E ex ante and ex post net savings and realization rates by measure group, 2017

Measure Group	Ex Ante			Ex Post			Net Realization Rates		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
CFL high wattage (> 30 W)	5,358,702	783	-67,967	199,165	30	-2,108	4%	4%	3%
LED A-lamp, all wattages	29,309,998	4,153	-384,015	5,944,104	825	-89,841	20%	20%	23%
LED reflector, all wattages	105,696,158	14,952	-1,383,451	20,350,744	2,898	-298,407	19%	19%	22%
Pass-through measures	14,292,806	1,637	-134,303	14,292,806	1,637	-134,303	100%	100%	100%
Overall	**154,657,664**	**21,524**	**-1,969,737**	**40,786,819**	**5,390**	**-524,659**	**26%**	**25%**	**27%**

This table omits the basic CFLs measure group because PG&E did not discount any basic CFLs in their 2017 upstream program.

Table 7-16 shows a breakdown of SDG&E ex post results split into residential and non-residential net savings. We explain how the residential and non-residential split is calculated and applied for the evaluated upstream measures in section 4.2.

Table 7-16. SDG&E ex post net savings by measure group and sector, 2017

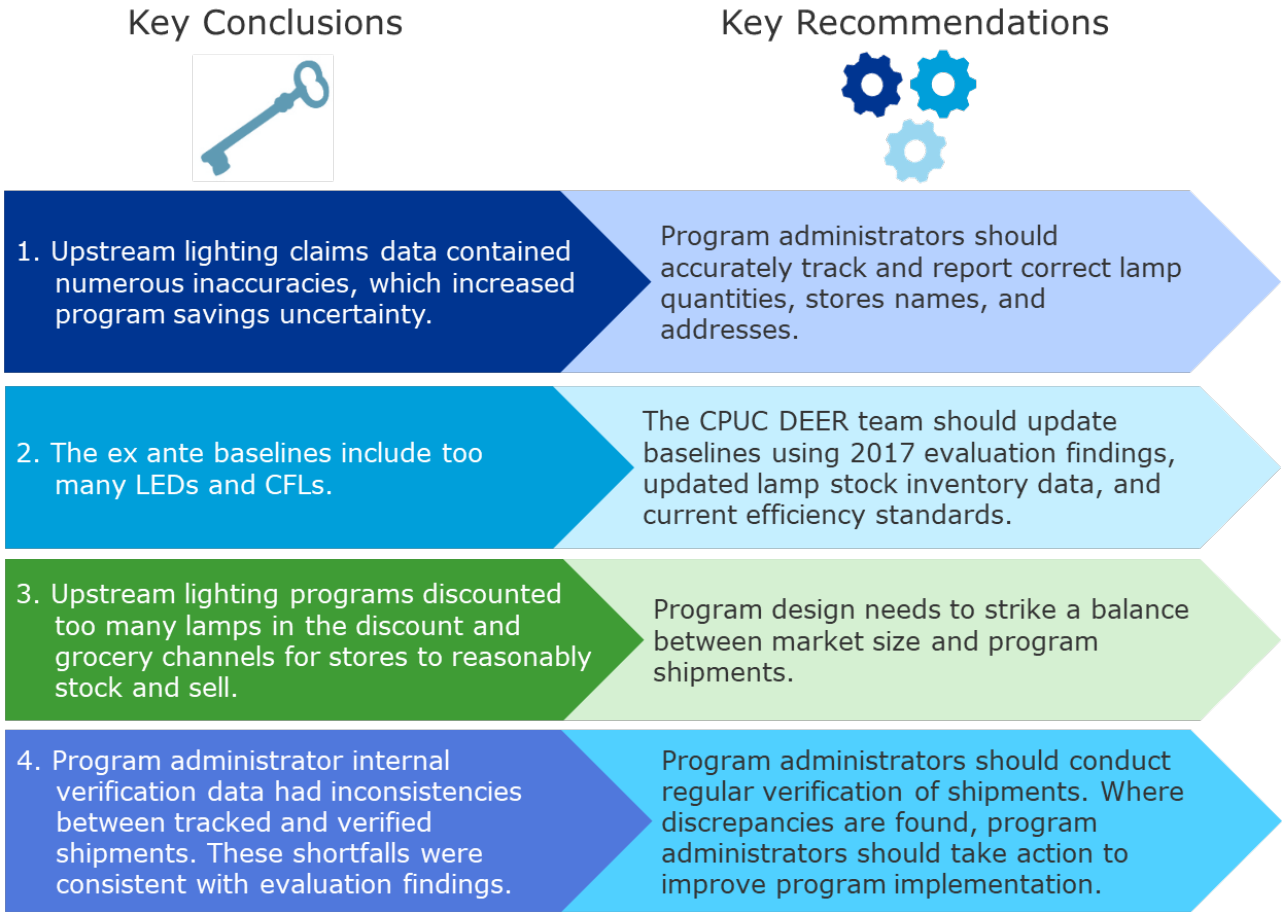
Measure Group	Annual Energy Savings (kWh)		Peak Demand Reductions (kW)		Gas Impact (Therms)	
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential
CFL high wattage (> 30 W)	165,642	33,523	19	11	-2,068	-41
LED A-lamp, all wattages	4,986,725	957,379	573	252	-87,147	-2,694
LED reflector, all wattages	16,198,279	4,152,464	1,862	1,036	-283,077	-15,330
Pass-through measures	11,727,240	2,565,566	991	646	-125,714	-8,590
Overall	**33,077,886**	**7,708,933**	**3,445**	**1,944**	**-498,005**	**-26,655**

This table omits the basic CFLs measure group because PG&E did not discount any basic CFLs in their 2017 upstream program.

8 CONCLUSIONS AND RECOMMENDATIONS

We summarize the primary conclusions and recommendations in a brief discussion of each following.

Figure 8-1. Key conclusions and recommendations



8.1 Conclusions and recommendations for programs

8.1.1 Tracking data and verification data issues

Program tracking data for the 2017 programs was not as complete as in recently evaluated program years. Tracking data discrepancies were identified as an issue in the 2006-2008 upstream lighting impact evaluation, but those issues were corrected in more recent programs. Issues for the 2017 program identified by the evaluation included missing or inaccurate store names, incomplete retail store addresses, and inaccurate shipment quantities. Multiple data requests and discussions were required with program staff for the evaluators to get a clear picture of program delivery. PA internal verification data contained inconsistences with the tracking data. Additionally, the PA internal verification data showed results that are consistent with the evaluation findings, but it is unclear if any action was taken as a result.

Based on these conclusions we have the following recommendations:

- **Recommendation 1:** PAs need to improve tracking and verification of program activity. Program tracking data at a minimum should have complete data on program shipment quantities and locations.
- **Recommendation 2:** PAs should also conduct more verification of program tracking data to verify that program shipments are being fully sold or will reasonably be sold in the near future. Where verification shows substantial discrepancies, PAs should take action to tighten control of distributions.
- **Recommendation 3:** Future upstream lighting impact evaluations will need to include invoice verification to confirm that the information provided in the tracking data is correct.

8.1.2 Gross baseline

Ex ante baselines were set according to the 2017 screw-in lamp disposition.[41] The ex ante baseline for lamps with greater than or equal to 90 lumens per watt[42] was set at 75% CFL and 25% halogen, and the baseline for lamps with less than 90 lumens per watt was set at 55% CFL, 20% LED and 25% halogen. To avoid double counting free-ridership,[43] the ex ante baselines were offset in the 2017 disposition by raising net-to-gross ratios. This evaluation found that the evaluated retail baselines included more inefficient technologies than were included in the ex ante assumptions. This resulted in higher baseline wattages, greater unit energy savings, and lower net-to-gross ratios for LED lamps.

Based on these conclusions, we have the following recommendation:

- **Recommendation 4:** Ex ante baseline assumptions should be updated to reflect the evaluated results in this evaluation. The ex ante team should also set projected baselines moving forward that account for the 2017 evaluation findings, updated lamp stock inventory data, and statewide and national efficiency standards.

8.1.3 Quantity adjustments

One of the most important conclusions from this evaluation is that the programs discounted and shipped more lamps to the non-big box channels than these channels could support. The 2015 evaluation provided the following recommendation:

"The PAs should consider shifting more of their upstream lighting program incentives toward the non-big box channels to minimize free-ridership and maximize net UES. However, we acknowledge that these channels are not capable of moving a large volume of program-discounted lamps as quickly as the big box channels, so some effort may be required to strike the appropriate balance between program effectiveness and volume."

In program year 2017, SCE and SDG&E shifted program incentives towards the discount and grocery channels. These measures achieved the intended effect of maximizing net unit energy savings; however, the volume of lamps shipped to these channels was far greater than the volume of lamps that they could sell.

Based on these conclusions we have the following recommendations:

- **Recommendation 5:** PAs need to do a better job of tracking and verifying program activity. Program tracking data at a minimum should have complete data on program shipment quantities and locations.

[41] "Comprehensive workpaper disposition for Screw-in Lamps. Revisions to disposition originally issued March 1, 2017." California Public Utilities Commission, Energy Division. May 26, 2017.

[42] The 2017 screw in lamp disposition uses lumens per watt as a way to scale assumptions across a wide range of measures.

[43] See Section 5.4

- **Recommendation 6:** PAs should allocate more resources to verifying program activity. This should include internal verification of shipment information coming from manufacturers and distributors as well as in-store verifications of sell-through rates and stocking. We recommend that program tracking include this verification of sell through rates for program shipments.

8.2 Further research

Based on the conclusions and recommendations for programs from this evaluation, we have identified potential topics for further research.

8.2.1 Sales-to-shipment verification research

This evaluation has found that there was limited and inconsistent verification of the shipment and sales of the lamps in the program tracking data. Future research should focus on upstream measure sell through rates designed to address these specific areas:

- A program supply and distribution chain audit for a full accounting of program activity from the program discounts, the distribution of lamps to stores, to the quantities of shipments claimed in tracking data
- In-store research targeted at how program lamps are displayed and sold; this research should also focus on what is done with unsold program lamps and stocking patterns at participating stores.
- Additional research focusing on program leakage to areas outside of the IOU service territories
- Supplier and manufacturer interviews[44] to understand program impacts on market sizes

8.2.2 Market size assessments

Further research is needed to understand the market size for replacement lamps. This evaluation found that current program design is not adequately estimating the available market within specific channels and individual stores for certain measures. A market assessment study could characterize and quantify the size of different channels to better understand the statewide market demand for program measures.

8.2.3 Upstream lighting baseline projection model

One of the key recommendations from this evaluation is that ex ante baseline assumptions should be updated to reflect the evaluated results in this evaluation. Further research could be conducted to create a model to project baselines forward for future program planning, which can be updated and calibrated with data from future evaluations. Future evaluations should continue to research the evolving baseline as new lamp efficiency standards in California's Title 20 took effect in 2018, and EISA Tier 2 standards will take effect in 2020.

8.2.4 Residential lighting usage patterns

Lighting programs and measures are continuing to evolve as the market changes. The last study that measured actual residential lighting usage was the 2006-2008 impact evaluation metering study.[45] The hours of use and peak coincidence factors in this evaluation still rely on the meter data from that study. An In-Home Lighting Inventory and Metering Study Research Plan was scoped for the CPUC in 2017.[46]

[44] Supplier and manufacturer interviews will be included in the 2018 impact evaluation

[45] KEMA, Inc. and Cadmus Group 2010.

[46] DNV GL 2017a.

Stakeholders should review this research plan and assess whether a new study investigating residential lighting usage patterns is needed to update gross saving assumptions for future lighting programs.

8.2.5 Residential versus non-residential split

Assumptions regarding the residential and non-residential split should be revisited. The splits used in both this evaluation and ex ante assumptions were developed as a result of large onsite saturation surveys, both residential[47] and commercial,[48] during the 2010-2012 program cycle. It is likely that as program activity and lighting technologies have shifted, the purchasing patterns of both residential and non-residential customers have shifted as well.

[47] DNV GL 2014a

[48] Itron, Inc., 2014

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10 APPENDICES

10.1 Appendix A: Data standardized high level savings

Gross Lifecycle Savings (MWh)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	3,118	3,638	1.17	0.0%	1.17
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	17,272	19,777	1.15	0.0%	1.15
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	52,471	59,363	1.13	0.0%	1.13
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	4,660	8,146	1.75	0.0%	1.75
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	109,473	212,648	1.94	0.0%	1.94
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	325,318	646,557	1.99	0.0%	1.99
PGE	PassThrough Residential Downstream	37,677	37,194	0.99	100.0%	
PGE	PassThrough Upstream	149,730	149,730	1.00	100.0%	
PGE	**Total**	**699,721**	**1,137,051**	**1.63**	**26.8%**	**1.85**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	45,659	11,582	0.25	0.0%	0.25
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	98	109	1.12	0.0%	1.12
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	78,160	27,158	0.35	0.0%	0.35
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	232,858	100,873	0.43	0.0%	0.43
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	201,890	77,042	0.38	0.0%	0.38
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	205	289	1.41	0.0%	1.41
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	598,187	511,240	0.85	0.0%	0.85
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	1,774,822	1,267,557	0.71	0.0%	0.71
SCE	PassThrough Residential Downstream	273,559	305,485	1.12	100.0%	
SCE	**Total**	**3,205,438**	**2,301,336**	**0.72**	**8.5%**	**0.68**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	9,464	283	0.03	0.0%	0.03
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	65,057	13,094	0.20	0.0%	0.20
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	224,857	46,119	0.21	0.0%	0.21
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	37,632	4,482	0.12	0.0%	0.12
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	410,849	123,851	0.30	0.0%	0.30
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	1,420,910	366,739	0.26	0.0%	0.26
SDGE	PassThrough Residential Downstream	115,108	115,108	1.00	100.0%	
SDGE	PassThrough Upstream	201,438	201,438	1.00	100.0%	
SDGE	**Total**	**2,485,316**	**871,114**	**0.35**	**12.7%**	**0.26**
	Statewide	***6,390,475***	***4,309,501***	***0.67***	***12.2%***	***0.62***

Net Lifecycle Savings (MWh)

PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	1,840	2,146	1.17	0.0%	0.59	0.59	0.59	0.59
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	12,608	14,443	1.15	0.0%	0.73	0.73	0.73	0.73
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	46,405	51,551	1.11	0.0%	0.88	0.87	0.88	0.87
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	4,427	1,802	0.41	0.0%	0.95	0.22	0.95	0.22
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	75,270	194,489	2.58	0.0%	0.69	0.91	0.69	0.91
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	282,499	553,440	1.96	0.0%	0.87	0.86	0.87	0.86
PGE	PassThrough Residential Downstream	28,328	28,016	0.99	100.0%	0.75	0.75		
PGE	PassThrough Upstream	90,900	90,900	1.00	100.0%	0.61	0.61		
PGE	**Total**	**542,277**	**936,787**	**1.73**	**22.0%**	**0.77**	**0.82**	**0.83**	**0.86**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	41,093	10,424	0.25	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	88	99	1.12	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	54,410	19,674	0.36	0.0%	0.70	0.72	0.70	0.72
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	190,643	82,167	0.43	0.0%	0.82	0.81	0.82	0.81
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	181,701	39,965	0.22	0.0%	0.90	0.52	0.90	0.52
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	176	63	0.36	0.0%	0.86	0.22	0.86	0.22
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	392,853	455,327	1.16	0.0%	0.66	0.89	0.66	0.89
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	1,413,285	1,039,273	0.74	0.0%	0.80	0.82	0.80	0.82
SCE	PassThrough Residential Downstream	202,297	226,242	1.12	100.0%	0.74	0.74		
SCE	**Total**	**2,476,547**	**1,873,234**	**0.76**	**8.2%**	**0.77**	**0.81**	**0.78**	**0.83**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	6,225	242	0.04	0.0%	0.66	0.85	0.66	0.85
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	58,941	9,654	0.16	0.0%	0.91	0.74	0.91	0.74
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	211,368	41,339	0.20	0.0%	0.94	0.90	0.94	0.90
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	35,554	1,605	0.05	0.0%	0.94	0.36	0.94	0.36
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	368,636	85,980	0.23	0.0%	0.90	0.69	0.90	0.69
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	1,331,364	277,509	0.21	0.0%	0.94	0.76	0.94	0.76
SDGE	PassThrough Residential Downstream	76,945	76,945	1.00	100.0%	0.67	0.67		
SDGE	PassThrough Upstream	122,880	122,880	1.00	100.0%	0.61	0.61		
SDGE	**Total**	**2,211,912**	**616,155**	**0.28**	**9.0%**	**0.89**	**0.71**	**0.93**	**0.75**
	Statewide	***5,230,736***	***3,426,176***	***0.66***	***10.0%***	***0.82***	***0.80***	***0.84***	***0.82***

Gross Lifecycle Savings (MW)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.7	0.9	1.17	0.0%	1.17
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	4.1	4.7	1.14	0.0%	1.14
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	12.4	14.0	1.13	0.0%	1.13
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.6	1.0	1.86	0.0%	1.86
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	13.1	26.6	2.03	0.0%	2.03
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	39.0	80.9	2.08	0.0%	2.08
PGE	PassThrough Residential Downstream	4.3	4.3	0.98	100.0%	
PGE	PassThrough Upstream	20.4	20.4	1.00	100.0%	
PGE	**Total**	**94.6**	**152.7**	**1.62**	**26.2%**	**1.83**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	15.0	3.9	0.26	0.0%	0.26
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	1.13	0.0%	1.13
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	25.3	8.8	0.35	0.0%	0.35
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	75.4	32.6	0.43	0.0%	0.43
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	22.8	9.7	0.43	0.0%	0.43
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	1.88	0.0%	1.88
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	65.2	62.9	0.96	0.0%	0.96
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	203.4	156.1	0.77	0.0%	0.77
SCE	PassThrough Residential Downstream	9.6	9.8	1.03	100.0%	
SCE	**Total**	**416.7**	**283.8**	**0.68**	**2.3%**	**0.67**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	2.4	0.1	0.04	0.0%	0.04
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	16.2	3.4	0.21	0.0%	0.21
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	56.1	11.5	0.21	0.0%	0.21
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	4.2	0.5	0.12	0.0%	0.12
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	46.2	14.2	0.31	0.0%	0.31
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	159.5	42.2	0.26	0.0%	0.26
SDGE	PassThrough Residential Downstream	4.7	4.7	1.00	100.0%	
SDGE	PassThrough Upstream	27.8	27.8	1.00	100.0%	
SDGE	**Total**	**317.1**	**104.4**	**0.33**	**10.2%**	**0.25**
	Statewide	***828.3***	***541.0***	***0.65***	***8.1%***	***0.62***

Net Lifecycle Savings (MW)

PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.4	0.5	1.17	0.0%	0.59	0.59	0.59	0.59
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	3.0	3.4	1.14	0.0%	0.73	0.73	0.73	0.73
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	11.0	12.2	1.11	0.0%	0.88	0.87	0.88	0.87
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.5	0.2	0.43	0.0%	0.95	0.22	0.95	0.22
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	9.0	24.3	2.71	0.0%	0.69	0.91	0.69	0.91
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	33.8	69.2	2.04	0.0%	0.87	0.86	0.87	0.86
PGE	PassThrough Residential Downstream	3.3	3.3	0.99	100.0%	0.76	0.76		
PGE	PassThrough Upstream	12.5	12.5	1.00	100.0%	0.61	0.61		
PGE	**Total**	**73.5**	**125.6**	**1.71**	**21.5%**	**0.78**	**0.82**	**0.83**	**0.86**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	13.5	3.5	0.26	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	1.13	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	17.6	6.4	0.36	0.0%	0.70	0.72	0.70	0.72
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	61.8	26.6	0.43	0.0%	0.82	0.81	0.82	0.81
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	20.5	5.0	0.25	0.0%	0.90	0.52	0.90	0.52
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	0.49	0.0%	0.84	0.22	0.84	0.22
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	43.3	56.1	1.30	0.0%	0.66	0.89	0.66	0.89
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	164.1	127.9	0.78	0.0%	0.81	0.82	0.81	0.82
SCE	PassThrough Residential Downstream	7.3	7.5	1.03	100.0%	0.76	0.76		
SCE	**Total**	**328.0**	**232.9**	**0.71**	**2.2%**	**0.79**	**0.82**	**0.79**	**0.82**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	1.5	0.1	0.05	0.0%	0.66	0.86	0.66	0.86
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	14.7	2.5	0.17	0.0%	0.91	0.74	0.91	0.74
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	52.7	10.3	0.20	0.0%	0.94	0.90	0.94	0.90
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	4.0	0.2	0.05	0.0%	0.94	0.36	0.94	0.36
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	41.4	9.9	0.24	0.0%	0.90	0.69	0.90	0.69
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	149.5	31.9	0.21	0.0%	0.94	0.76	0.94	0.76
SDGE	PassThrough Residential Downstream	3.6	3.6	1.00	100.0%	0.77	0.77		
SDGE	PassThrough Upstream	17.2	17.2	1.00	100.0%	0.62	0.62		
SDGE	**Total**	**284.7**	**75.7**	**0.27**	**7.3%**	**0.90**	**0.72**	**0.93**	**0.76**
	Statewide	***686.2***	***434.2***	***0.63***	***6.4%***	***0.83***	***0.80***	***0.84***	***0.82***

Gross Lifecycle Savings (MTherms)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-20	-24	1.17	0.0%	1.17
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-206	-134	0.65	0.0%	0.65
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-343	-387	1.13	0.0%	1.13
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-104	-166	1.59	0.0%	1.59
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-2,443	-5,071	2.08	0.0%	2.08
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-7,240	-15,418	2.13	0.0%	2.13
PGE	PassThrough Residential Downstream	-669	-667	1.00	100.0%	
PGE	PassThrough Upstream	-2,989	-2,989	1.00	100.0%	
PGE	**Total**	**-14,014**	**-24,854**	**1.77**	**26.1%**	**2.05**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-2,757	-14	0.00	0.0%	0.00
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	-1	0	0.15	0.0%	0.15
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-752	-27	0.04	0.0%	0.04
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-244	-102	0.42	0.0%	0.42
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-3,768	-1,434	0.38	0.0%	0.38
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	-4	-5	1.32	0.0%	1.32
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-11,278	-9,460	0.84	0.0%	0.84
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-32,685	-23,456	0.72	0.0%	0.72
SCE	PassThrough Residential Downstream	-1,438	-1,438	1.00	100.0%	
SCE	**Total**	**-52,927**	**-35,937**	**0.68**	**2.7%**	**0.67**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-623	0	0.00	0.0%	0.00
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-3,705	-38	0.01	0.0%	0.01
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-830	-170	0.21	0.0%	0.21
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-623	-56	0.09	0.0%	0.09
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-6,564	-2,164	0.33	0.0%	0.33
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-22,211	-6,409	0.29	0.0%	0.29
SDGE	PassThrough Residential Downstream	-486	-486	1.00	100.0%	
SDGE	PassThrough Upstream	-4,302	-2,698	0.63	100.0%	
SDGE	**Total**	**-39,344**	**-12,022**	**0.31**	**12.2%**	**0.26**
	Statewide	***-106,286***	***-72,813***	***0.69***	***9.3%***	***0.67***

Net Lifecycle Savings (MTherms)

PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-12	-14	1.17	0.0%	0.59	0.59	0.59	0.59
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-138	-98	0.71	0.0%	0.67	0.73	0.67	0.73
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-304	-336	1.11	0.0%	0.88	0.87	0.88	0.87
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-99	-37	0.37	0.0%	0.95	0.22	0.95	0.22
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-1,679	-4,638	2.76	0.0%	0.69	0.91	0.69	0.91
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-6,289	-13,197	2.10	0.0%	0.87	0.86	0.87	0.86
PGE	PassThrough Residential Downstream	-519	-518	1.00	100.0%	0.78	0.78		
PGE	PassThrough Upstream	-1,800	-1,800	1.00	100.0%	0.60	0.60		
PGE	**Total**	**-10,840**	**-20,638**	**1.90**	**21.4%**	**0.77**	**0.83**	**0.82**	**0.86**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-2,481	-12	0.00	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0	0.21	0.0%	0.63	0.90	0.63	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-702	-20	0.03	0.0%	0.93	0.73	0.93	0.73
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-202	-84	0.41	0.0%	0.83	0.82	0.83	0.82
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-3,391	-744	0.22	0.0%	0.90	0.52	0.90	0.52
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	-3	-1	0.34	0.0%	0.86	0.22	0.86	0.22
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-7,386	-8,426	1.14	0.0%	0.65	0.89	0.65	0.89
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-25,857	-19,231	0.74	0.0%	0.79	0.82	0.79	0.82
SCE	PassThrough Residential Downstream	-1,056	-1,056	1.00	100.0%	0.73	0.73		
SCE	**Total**	**-41,080**	**-29,575**	**0.72**	**2.6%**	**0.78**	**0.82**	**0.78**	**0.83**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-579	0	0.00	0.0%	0.93	0.76	0.93	0.76
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-3,544	-27	0.01	0.0%	0.96	0.73	0.96	0.73
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-780	-153	0.20	0.0%	0.94	0.90	0.94	0.90
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-579	-20	0.03	0.0%	0.93	0.36	0.93	0.36
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-5,898	-1,503	0.25	0.0%	0.90	0.69	0.90	0.69
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-20,807	-4,850	0.23	0.0%	0.94	0.76	0.94	0.76
SDGE	PassThrough Residential Downstream	-376	-376	1.00	100.0%	0.77	0.77		
SDGE	PassThrough Upstream	-2,592	-1,626	0.63	100.0%	0.60	0.60		
SDGE	**Total**	**-35,154**	**-8,554**	**0.24**	**8.4%**	**0.89**	**0.71**	**0.93**	**0.74**
	Statewide	***-87,074***	***-58,766***	***0.67***	***7.3%***	***0.82***	***0.81***	***0.84***	***0.83***

Gross First Year Savings (MWh)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	663	774	1.17	0.0%	1.17
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	1,839	2,106	1.15	0.0%	1.15
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	5,576	6,313	1.13	0.0%	1.13
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	1,331	2,327	1.75	0.0%	1.75
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	6,842	13,290	1.94	0.0%	1.94
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	20,332	40,410	1.99	0.0%	1.99
PGE	PassThrough Residential Downstream	2,712	2,657	0.98	100.0%	
PGE	PassThrough Upstream	10,235	10,235	1.00	100.0%	
PGE	**Total**	**49,532**	**78,112**	**1.58**	**26.1%**	**1.78**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	6,298	1,598	0.25	0.0%	0.25
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	14	15	1.12	0.0%	1.12
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	6,513	2,289	0.35	0.0%	0.35
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	19,405	8,406	0.43	0.0%	0.43
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	57,683	22,012	0.38	0.0%	0.38
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	59	82	1.41	0.0%	1.41
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	37,387	31,953	0.85	0.0%	0.85
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	110,926	79,228	0.71	0.0%	0.71
SCE	PassThrough Residential Downstream	22,445	22,445	1.00	100.0%	
SCE	**Total**	**260,729**	**168,028**	**0.64**	**8.6%**	**0.61**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	2,014	43	0.02	0.0%	0.02
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	6,921	1,393	0.20	0.0%	0.20
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	23,921	4,906	0.21	0.0%	0.21
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	4,269	537	0.13	0.0%	0.13
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	25,678	7,741	0.30	0.0%	0.30
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	88,807	22,921	0.26	0.0%	0.26
SDGE	PassThrough Residential Downstream	8,269	8,269	1.00	100.0%	
SDGE	PassThrough Upstream	14,206	14,206	1.00	100.0%	
SDGE	**Total**	**174,084**	**60,016**	**0.34**	**12.9%**	**0.25**
	Statewide	***484,345***	***306,156***	***0.63***	***11.9%***	***0.58***

Net First Year Savings (MWh)

PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	391	457	1.17	0.0%	0.59	0.59	0.59	0.59
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	1,342	1,538	1.15	0.0%	0.73	0.73	0.73	0.73
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	4,930	5,482	1.11	0.0%	0.88	0.87	0.88	0.87
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	1,265	515	0.41	0.0%	0.95	0.22	0.95	0.22
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	4,704	12,156	2.58	0.0%	0.69	0.91	0.69	0.91
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	17,656	34,590	1.96	0.0%	0.87	0.86	0.87	0.86
PGE	PassThrough Residential Downstream	1,999	1,963	0.98	100.0%	0.74	0.74		
PGE	PassThrough Upstream	6,251	6,251	1.00	100.0%	0.61	0.61		
PGE	**Total**	**38,540**	**62,951**	**1.63**	**21.4%**	**0.78**	**0.81**	**0.83**	**0.84**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	5,668	1,438	0.25	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	12	14	1.12	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	4,534	1,660	0.37	0.0%	0.70	0.73	0.70	0.73
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	15,887	6,847	0.43	0.0%	0.82	0.81	0.82	0.81
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	51,915	11,418	0.22	0.0%	0.90	0.52	0.90	0.52
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	50	18	0.36	0.0%	0.86	0.22	0.86	0.22
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	24,553	28,458	1.16	0.0%	0.66	0.89	0.66	0.89
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	88,330	64,959	0.74	0.0%	0.80	0.82	0.80	0.82
SCE	PassThrough Residential Downstream	16,793	16,793	1.00	100.0%	0.75	0.75		
SCE	**Total**	**207,743**	**131,605**	**0.63**	**8.1%**	**0.80**	**0.78**	**0.80**	**0.79**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	1,324	36	0.03	0.0%	0.66	0.84	0.66	0.84
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	6,270	1,027	0.16	0.0%	0.91	0.74	0.91	0.74
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	22,486	4,398	0.20	0.0%	0.94	0.90	0.94	0.90
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	4,034	193	0.05	0.0%	0.95	0.36	0.95	0.36
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	23,040	5,374	0.23	0.0%	0.90	0.69	0.90	0.69
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	83,210	17,344	0.21	0.0%	0.94	0.76	0.94	0.76
SDGE	PassThrough Residential Downstream	5,555	5,555	1.00	100.0%	0.67	0.67		
SDGE	PassThrough Upstream	8,738	8,738	1.00	100.0%	0.62	0.62		
SDGE	**Total**	**154,658**	**42,664**	**0.28**	**9.2%**	**0.89**	**0.71**	**0.93**	**0.76**
	Statewide	***400,940***	***237,220***	***0.59***	***9.8%***	***0.83***	***0.77***	***0.85***	***0.80***

Gross First Year Savings (MW)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.2	0.2	1.17	0.0%	1.17
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0.4	0.5	1.14	0.0%	1.14
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	1.3	1.5	1.13	0.0%	1.13
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.2	0.3	1.86	0.0%	1.86
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0.8	1.7	2.03	0.0%	2.03
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	2.4	5.1	2.08	0.0%	2.08
PGE	PassThrough Residential Downstream	0.3	0.3	0.97	100.0%	
PGE	PassThrough Upstream	1.5	1.5	1.00	100.0%	
PGE	**Total**	**7.1**	**11.0**	**1.54**	**25.2%**	**1.73**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	2.1	0.5	0.26	0.0%	0.26
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	1.13	0.0%	1.13
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	2.1	0.7	0.35	0.0%	0.35
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	6.3	2.7	0.43	0.0%	0.43
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	6.5	2.8	0.43	0.0%	0.43
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	1.88	0.0%	1.88
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	4.1	3.9	0.96	0.0%	0.96
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	12.7	9.8	0.77	0.0%	0.77
SCE	PassThrough Residential Downstream	0.7	0.7	1.00	100.0%	
SCE	**Total**	**34.5**	**21.2**	**0.61**	**2.1%**	**0.61**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.5	0.0	0.03	0.0%	0.03
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	1.7	0.4	0.21	0.0%	0.21
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	6.0	1.2	0.21	0.0%	0.21
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.5	0.1	0.13	0.0%	0.13
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	2.9	0.9	0.31	0.0%	0.31
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	10.0	2.6	0.26	0.0%	0.26
SDGE	PassThrough Residential Downstream	0.4	0.4	1.00	100.0%	
SDGE	PassThrough Upstream	2.1	2.1	1.00	100.0%	
SDGE	**Total**	**24.1**	**7.7**	**0.32**	**10.5%**	**0.24**
	Statewide	***65.7***	***39.9***	***0.61***	***7.7%***	***0.57***

Net First Year Savings (MW)

PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.1	0.1	1.17	0.0%	0.59	0.59	0.59	0.59
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0.3	0.4	1.14	0.0%	0.73	0.73	0.73	0.73
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	1.2	1.3	1.11	0.0%	0.88	0.87	0.88	0.87
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.2	0.1	0.43	0.0%	0.95	0.22	0.95	0.22
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0.6	1.5	2.71	0.0%	0.69	0.91	0.69	0.91
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	2.1	4.3	2.04	0.0%	0.87	0.86	0.87	0.86
PGE	PassThrough Residential Downstream	0.2	0.2	0.98	100.0%	0.74	0.75		
PGE	PassThrough Upstream	0.9	0.9	1.00	100.0%	0.62	0.62		
PGE	**Total**	**5.6**	**8.8**	**1.59**	**20.7%**	**0.78**	**0.80**	**0.83**	**0.84**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	1.9	0.5	0.26	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	1.13	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	1.5	0.5	0.37	0.0%	0.70	0.73	0.70	0.73
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	5.1	2.2	0.43	0.0%	0.82	0.81	0.82	0.81
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	5.9	1.4	0.25	0.0%	0.90	0.52	0.90	0.52
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0.0	0.0	0.49	0.0%	0.84	0.22	0.84	0.22
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	2.7	3.5	1.30	0.0%	0.66	0.89	0.66	0.89
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	10.3	8.0	0.78	0.0%	0.81	0.82	0.81	0.82
SCE	PassThrough Residential Downstream	0.5	0.5	1.00	100.0%	0.75	0.75		
SCE	**Total**	**27.8**	**16.7**	**0.60**	**1.9%**	**0.81**	**0.79**	**0.81**	**0.79**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.3	0.0	0.03	0.0%	0.66	0.85	0.66	0.85
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	1.6	0.3	0.17	0.0%	0.91	0.74	0.91	0.74
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	5.6	1.1	0.20	0.0%	0.94	0.90	0.94	0.90
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0.5	0.0	0.05	0.0%	0.95	0.36	0.95	0.36
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	2.6	0.6	0.24	0.0%	0.90	0.69	0.90	0.69
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	9.3	2.0	0.21	0.0%	0.94	0.76	0.94	0.76
SDGE	PassThrough Residential Downstream	0.3	0.3	1.00	100.0%	0.76	0.76		
SDGE	PassThrough Upstream	1.3	1.3	1.00	100.0%	0.63	0.63		
SDGE	**Total**	**21.5**	**5.6**	**0.26**	**7.6%**	**0.89**	**0.73**	**0.92**	**0.77**
	Statewide	***54.9***	***31.2***	***0.57***	***6.0%***	***0.84***	***0.78***	***0.85***	***0.80***

Gross First Year Savings (MTherms)

PA	Standard Report Group	Ex-Ante Gross	Ex-Post Gross	GRR	% Ex-Ante Gross Pass Through	Eval GRR
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-4	-5	1.17	0.0%	1.17
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-18	-14	0.80	0.0%	0.80
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-36	-41	1.13	0.0%	1.13
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-30	-47	1.59	0.0%	1.59
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-153	-317	2.07	0.0%	2.07
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-453	-964	2.13	0.0%	2.13
PGE	PassThrough Residential Downstream	-44	-43	0.99	100.0%	
PGE	PassThrough Upstream	-192	-192	1.00	100.0%	
PGE	**Total**	**-930**	**-1,624**	**1.75**	**25.4%**	**2.00**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-780	-2	0.00	0.0%	0.00
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0	0.08	0.0%	0.08
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-49	-2	0.05	0.0%	0.05
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-20	-9	0.42	0.0%	0.42
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-1,076	-410	0.38	0.0%	0.38
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	-1	-2	1.32	0.0%	1.32
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-705	-591	0.84	0.0%	0.84
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-2,043	-1,466	0.72	0.0%	0.72
SCE	PassThrough Residential Downstream	-130	-130	1.00	100.0%	
SCE	**Total**	**-4,804**	**-2,611**	**0.54**	**2.7%**	**0.53**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-74	0	0.00	0.0%	0.00
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-242	-4	0.02	0.0%	0.02
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-88	-18	0.21	0.0%	0.21
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-74	-7	0.09	0.0%	0.09
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-416	-135	0.33	0.0%	0.33
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-1,388	-401	0.29	0.0%	0.29
SDGE	PassThrough Residential Downstream	-38	-38	1.00	100.0%	
SDGE	PassThrough Upstream	-277	-174	0.63	100.0%	
SDGE	**Total**	**-2,598**	**-777**	**0.30**	**12.1%**	**0.25**
	Statewide	***-8,332***	***-5,012***	***0.60***	***8.2%***	***0.58***

Net First Year Savings (MTherms)

PA	Standard Report Group	Ex-Ante Net	Ex-Post Net	NRR	% Ex-Ante Net Pass Through	Ex-Ante NTG	Ex-Post NTG	Eval Ex-Ante NTG	Eval Ex-Post NTG
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-3	-3	1.17	0.0%	0.59	0.59	0.59	0.59
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-12	-10	0.85	0.0%	0.69	0.73	0.69	0.73
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-32	-36	1.11	0.0%	0.88	0.87	0.88	0.87
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-28	-10	0.37	0.0%	0.95	0.22	0.95	0.22
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-105	-290	2.76	0.0%	0.69	0.91	0.69	0.91
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-393	-825	2.10	0.0%	0.87	0.86	0.87	0.86
PGE	PassThrough Residential Downstream	-34	-33	0.99	100.0%	0.77	0.77		
PGE	PassThrough Upstream	-116	-116	1.00	100.0%	0.60	0.60		
PGE	**Total**	**-723**	**-1,324**	**1.83**	**20.7%**	**0.78**	**0.82**	**0.83**	**0.85**
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-702	-2	0.00	0.0%	0.90	0.90	0.90	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0	0.11	0.0%	0.62	0.90	0.62	0.90
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-45	-2	0.04	0.0%	0.93	0.73	0.93	0.73
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-17	-7	0.41	0.0%	0.83	0.82	0.83	0.82
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-968	-213	0.22	0.0%	0.90	0.52	0.90	0.52
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	-1	0	0.34	0.0%	0.86	0.22	0.86	0.22
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-462	-527	1.14	0.0%	0.65	0.89	0.65	0.89
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-1,616	-1,202	0.74	0.0%	0.79	0.82	0.79	0.82
SCE	PassThrough Residential Downstream	-98	-98	1.00	100.0%	0.75	0.75		
SCE	**Total**	**-3,909**	**-2,050**	**0.52**	**2.5%**	**0.81**	**0.79**	**0.82**	**0.79**
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-68	0	0.00	0.0%	0.92	0.73	0.92	0.73
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	-231	-3	0.01	0.0%	0.95	0.73	0.95	0.73
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-83	-16	0.20	0.0%	0.94	0.90	0.94	0.90
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	-68	-2	0.04	0.0%	0.92	0.36	0.92	0.36
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	-374	-94	0.25	0.0%	0.90	0.69	0.90	0.69
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	-1,300	-303	0.23	0.0%	0.94	0.76	0.94	0.76
SDGE	PassThrough Residential Downstream	-29	-29	1.00	100.0%	0.76	0.76		
SDGE	PassThrough Upstream	-167	-105	0.63	100.0%	0.60	0.60		
SDGE	**Total**	**-2,321**	**-553**	**0.24**	**8.5%**	**0.89**	**0.71**	**0.93**	**0.74**
	Statewide	***-6,953***	***-3,926***	***0.56***	***6.4%***	***0.83***	***0.78***	***0.85***	***0.80***

10.2 Appendix B: Standardized per unit savings

Per Unit (Quantity) Gross Energy Savings (kWh)

PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	4.7	641.6	136.5	136.5
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	318.3	33.9	33.9
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	606.3	64.5	64.5
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	108.1	30.9	30.9
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	257.6	16.1	16.1
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	497.1	31.1	31.1
PGE	PassThrough Residential Downstream	1	0.0%		10.5	44.7	3.2	3.2
PGE	PassThrough Upstream	1	0.0%		15.6	223.3	15.3	15.3
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.2	186.0	25.7	25.7
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	7.2	373.2	51.8	51.8
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	11.9	238.3	20.1	20.1
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	12.0	599.9	50.0	50.0
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	78.9	22.6	22.6
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	3.5	62.8	17.9	17.9
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	286.3	17.9	17.9
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	481.1	30.1	30.1
SCE	PassThrough Residential Downstream	1	20.3%		15.1	443.4	32.6	32.6
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.1	226.8	34.2	34.2
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	336.8	35.8	35.8
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	850.9	90.5	90.5
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	8.3	229.4	27.5	27.5
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	203.3	12.7	12.7
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	431.9	27.0	27.0
SDGE	PassThrough Residential Downstream	1	0.0%		15.5	422.6	30.4	30.4
SDGE	PassThrough Upstream	1	0.0%		15.6	383.0	27.0	27.0

Note that per-unit savings do not include the installation rate

Per Unit (Quantity) Gross Energy Savings (Therms)

PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	4.7	-4.2	-0.9	-0.9
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	-2.2	-0.2	-0.2
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	-3.9	-0.4	-0.4
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	-2.2	-0.6	-0.6
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	-6.1	-0.4	-0.4
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	-11.9	-0.7	-0.7
PGE	PassThrough Residential Downstream	1	0.0%		10.5	-0.8	-0.1	-0.1
PGE	PassThrough Upstream	1	0.0%		15.6	-4.5	-0.3	-0.3
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.2	-0.2	0.0	0.0
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	7.2	-0.3	0.0	0.0
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	11.9	-0.2	0.0	0.0
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	12.0	-0.6	-0.1	-0.1
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	-1.5	-0.4	-0.4
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	3.5	-1.2	-0.3	-0.3
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	-5.3	-0.3	-0.3
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	-8.9	-0.6	-0.6
SCE	PassThrough Residential Downstream	1	20.3%		15.1	-2.1	-0.2	-0.2
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.1	-0.3	0.0	0.0
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	-1.0	-0.1	-0.1
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	-3.1	-0.3	-0.3
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	8.3	-2.9	-0.3	-0.3
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	-3.6	-0.2	-0.2
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	-7.5	-0.5	-0.5
SDGE	PassThrough Residential Downstream	1	0.0%		15.5	-1.8	-0.1	-0.1
SDGE	PassThrough Upstream	1	0.0%		15.6	-5.1	-0.3	-0.3

Note that per-unit savings do not include the installation rate

Per Unit (Quantity) Net Energy Savings (kWh)

PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	4.7	378.5	80.5	80.5
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	232.4	24.7	24.7
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	526.5	56.0	56.0
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	23.9	6.8	6.8
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	235.6	14.7	14.7
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	425.5	26.6	26.6
PGE	PassThrough Residential Downstream	1	0.0%		10.5	33.7	2.4	2.4
PGE	PassThrough Upstream	1	0.0%		15.6	135.6	9.3	9.3
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.2	167.4	23.1	23.1
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	7.2	335.8	46.6	46.6
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	11.9	172.6	14.6	14.6
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	12.0	488.7	40.7	40.7
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	41.0	11.7	11.7
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	3.5	13.7	3.9	3.9
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	255.0	15.9	15.9
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	394.5	24.7	24.7
SCE	PassThrough Residential Downstream	1	20.3%		15.1	328.4	24.4	24.4
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.1	193.8	28.6	28.6
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	248.3	26.4	26.4
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	762.7	81.1	81.1
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	8.3	82.2	9.9	9.9
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	141.2	8.8	8.8
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	326.8	20.4	20.4
SDGE	PassThrough Residential Downstream	1	0.0%		15.5	282.5	20.4	20.4
SDGE	PassThrough Upstream	1	0.0%		15.6	233.7	16.6	16.6

Note that per-unit savings do not include the installation rate

Per Unit (Quantity) Net Energy Savings (Therms)

PA	Standard Report Group	Pass Through	% ER Ex-Ante	% ER Ex-Post	Average EUL (yr)	Ex-Post Lifecycle	Ex-Post First Year	Ex-Post Annualized
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	4.7	-2.5	-0.5	-0.5
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	-1.6	-0.2	-0.2
PGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	-3.4	-0.4	-0.4
PGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	-0.5	-0.1	-0.1
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	-5.6	-0.4	-0.4
PGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	-10.1	-0.6	-0.6
PGE	PassThrough Residential Downstream	1	0.0%		10.5	-0.6	0.0	0.0
PGE	PassThrough Upstream	1	0.0%		15.6	-2.7	-0.2	-0.2
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.2	-0.2	0.0	0.0
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	7.2	-0.3	0.0	0.0
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	11.9	-0.2	0.0	0.0
SCE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	12.0	-0.5	0.0	0.0
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	3.5	-0.8	-0.2	-0.2
SCE	Evaluated Res UpstreamLIGHTING INDOOR CFL BASIC	0	0.0%	0.0%	3.5	-0.3	-0.1	-0.1
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	-4.7	-0.3	-0.3
SCE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	-7.3	-0.5	-0.5
SCE	PassThrough Residential Downstream	1	20.3%		15.1	-1.5	-0.1	-0.1
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	7.1	-0.2	0.0	0.0
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	9.4	-0.7	-0.1	-0.1
SDGE	Evaluated Non-res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	9.4	-2.8	-0.3	-0.3
SDGE	Evaluated Res UpstreamLIGHTING INDOOR CFL > 30 WATTS	0	0.0%	0.0%	8.3	-1.0	-0.1	-0.1
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED LAMP	0	0.0%	0.0%	16.0	-2.5	-0.2	-0.2
SDGE	Evaluated Res UpstreamLIGHTING INDOOR LED REFLECTOR LAMP	0	0.0%	0.0%	16.0	-5.7	-0.4	-0.4
SDGE	PassThrough Residential Downstream	1	0.0%		15.5	-1.4	-0.1	-0.1
SDGE	PassThrough Upstream	1	0.0%		15.6	-3.1	-0.2	-0.2

Note that per-unit savings do not include the installation rate

10.3 Appendix C: Recommendations

Study ID	Study Type	Study Title	Study Manager
Group A Lighting Sector	Impact Evaluation	Impact Evaluation of 2017 Upstream and Residential Downstream Lighting Programs	Abhi Wadhwa

Rec #	Program or Database	Summary of Findings	Additional Supporting Information	Best Practice / Recommendations	Recipient	Affected Workpaper or DEER
1	Upstream lighting programs	Program tracking data for the 2017 programs was not as complete as prior program years.	Tracking data discrepancies were identified as an issue in the 2006-2008 upstream lighting impact evaluation, but those issues were fixed in more recent programs. Issues for the 2017 program identified by the evaluation included missing or inaccurate store names, incomplete retail store addresses, and inaccurate shipment quantities. Multiple data requests and discussions were required with program staff for the evaluators to get a clear picture of program delivery. PA internal verification data contained inconsistences with the tracking data. Additionally, the PA internal verification data showed results that are consistent with the evaluation findings, but it is unclear if any action was taken as a result.	PAs need to improve tracking and verifying program activity. Program tracking data at a minimum should have complete data on program shipment quantities and locations.	All PAs	All upstream measures
2	Upstream lighting programs			PAs should also conduct more verification of program tracking data to verify that program shipments are being fully sold or will reasonably be sold in the near future. Where verification shows substantial discrepancies, PAs should take action to tighten control of distributions.		
3	Upstream lighting programs			Future upstream lighting impact evaluations will need to include invoice verification to confirm that the information provided in the tracking data is correct.		

Rec #	Program or Database	Summary of Findings	Additional Supporting Information	Best Practice / Recommendations	Recipient	Affected Workpaper or DEER
4	Upstream Lighting Programs	Ex post baselines were substantially higher than ex ante baselines.	Ex ante baselines were set according to the 2017 screw-in lamp disposition. The ex ante baseline for lamps with greater than or equal to 90 lumens per watt was set at 75% CFL and 25% halogen, and the baseline for lamps with less than 90 lumens per watt at 55% CFL, 20% LED and 25% halogen. To avoid double counting free-ridership , the ex ante baselines were offset in the 2017 disposition by raising net-to-gross ratios. This evaluation found that the evaluated retail baseline baselines included more inefficient technologies than were included in the ex ante assumptions. This resulted in higher baseline wattages, greater unit energy savings, and lower net-to-gross ratios for LED lamps.	Ex ante baseline assumptions should be updated to reflect the evaluated results in this evaluation. The ex ante team should also set projected baselines moving forward that account for the 2017 evaluation findings, updated lamp stock inventory data, and statewide and national efficiency standards.	Ex Ante Team	All Screw-in Lamps
5	Upstream Lighting Program	Upstream lighting programs discounted and shipped more lamps than the non-big box channels that they targeted could support.	In program year 2017, SCE and SDG&E shifted program incentives towards the discount and grocery channels. These measures achieved the intended effect of maximizing net unit energy savings; however, the volume of lamps shipped to these channels was far greater than	PAs need to do a better job of tracking and verifying program activity. Program tracking data at a minimum should have complete data on program shipment quantities and locations.	All IOUs	All upstream measures

Rec #	Program or Database	Summary of Findings	Additional Supporting Information	Best Practice / Recommendations	Recipient	Affected Workpaper or DEER
6			the volume of lamps that they could sell.	PAs should allocate more resources to verifying program activity. This should include internal verification of shipment information coming from manufacturers and distributors as well as in-store verifications of sell-through rates and stocking. We recommend that program tracking include this verification of sell through rates for program shipments.		

10.4 Appendix D: Waterfall graphics

In this section, we present waterfall graphics that to demonstrate the energy savings changes relative to each parameter.

LED A-lamps

Figure 10-1. Upstream and residential downstream LED A-lamps gross savings waterfall, PG&E

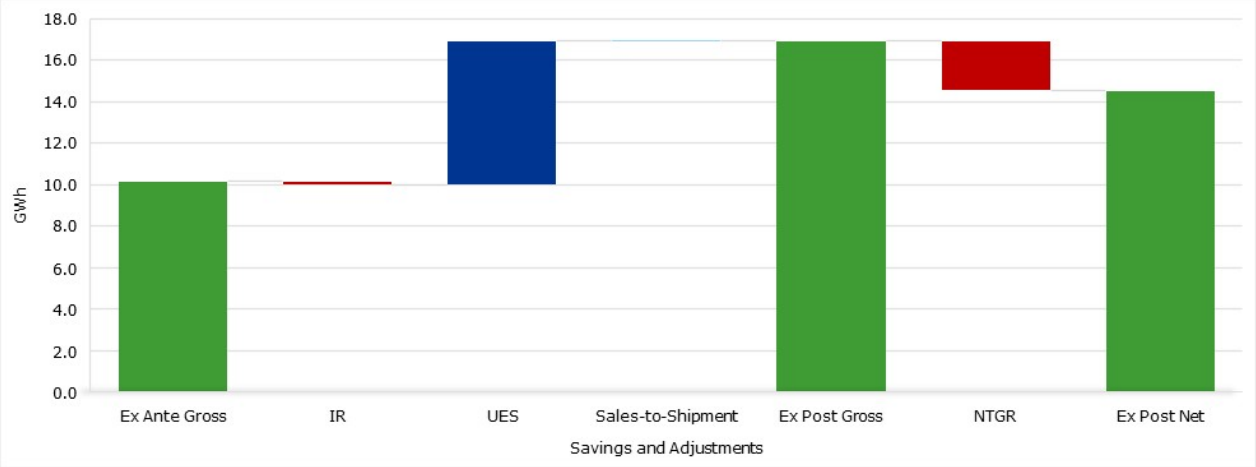


Figure 10-2. Upstream and residential downstream LED A-lamps gross savings waterfall, SCE

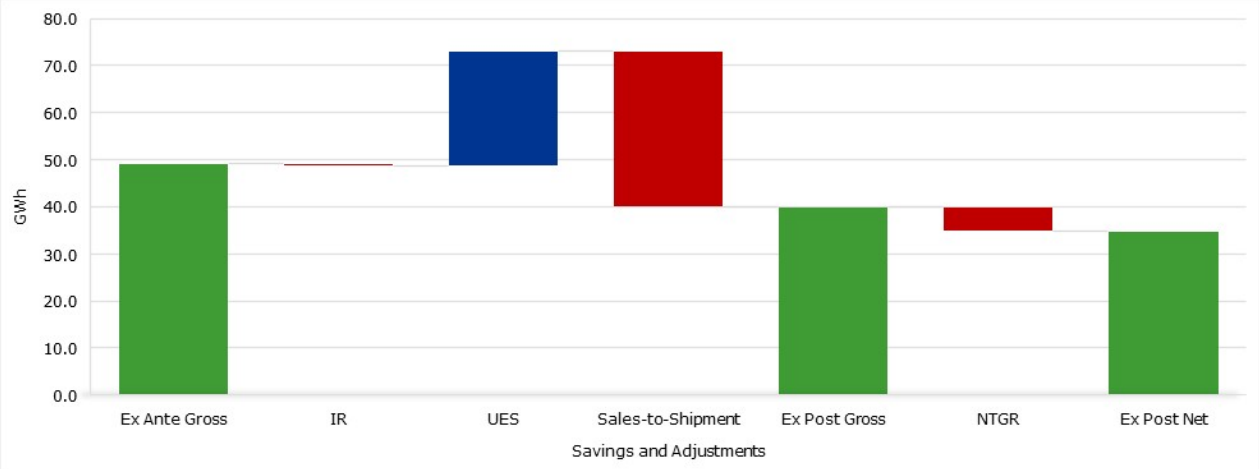
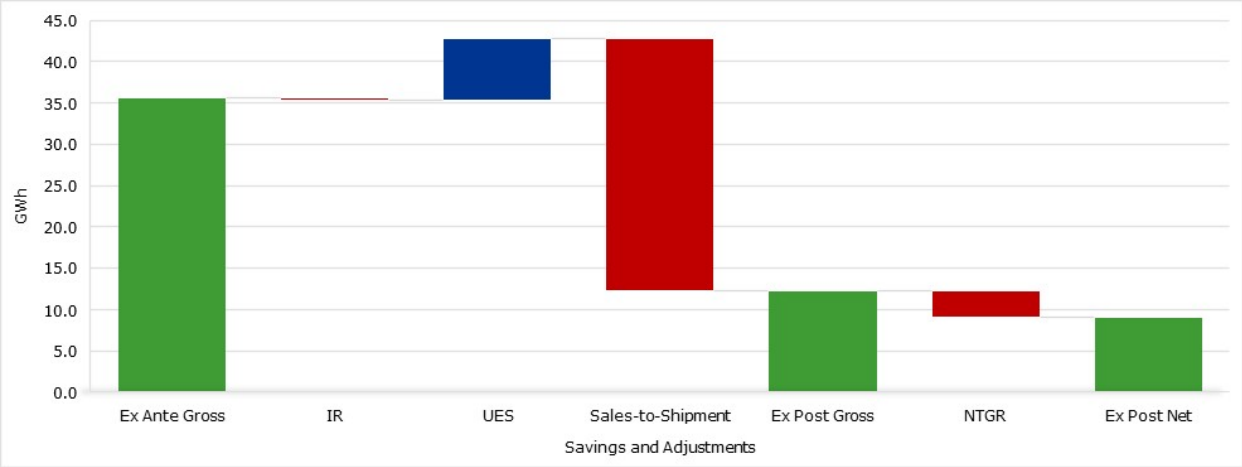


Figure 10-3. Upstream and residential downstream LED A-lamps gross savings waterfall, SDG&E



LED Reflectors

Figure 10-4. Upstream and residential downstream LED Reflectors gross savings waterfall, PG&E

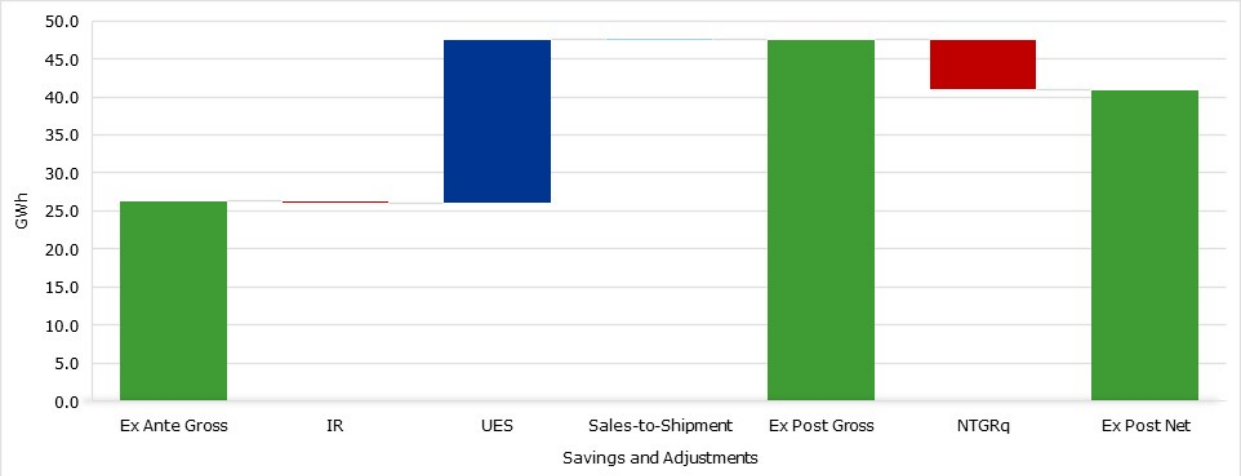


Figure 10-5. Upstream and residential downstream LED Reflectors gross savings waterfall, SCE

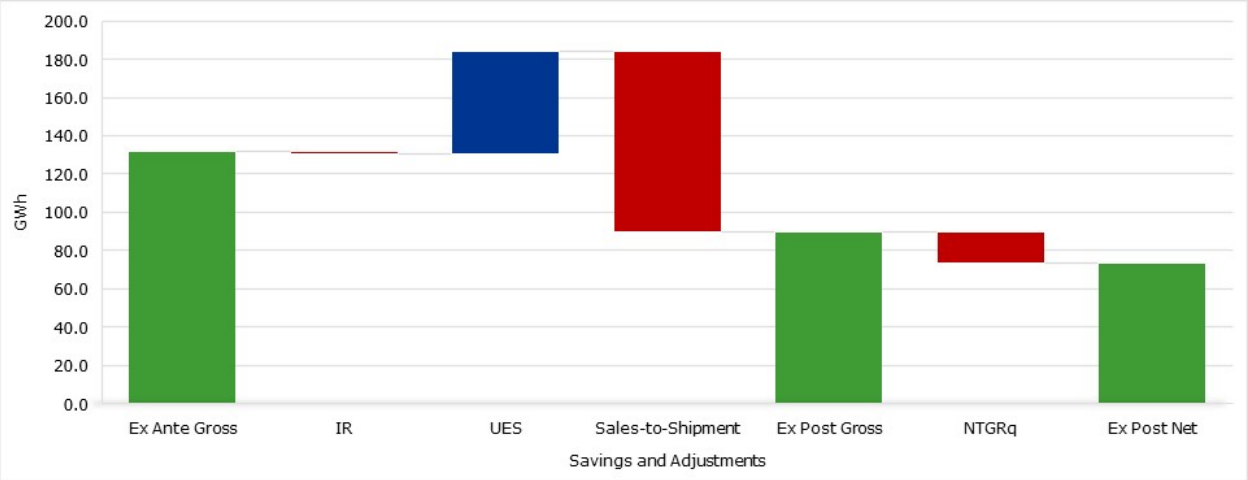
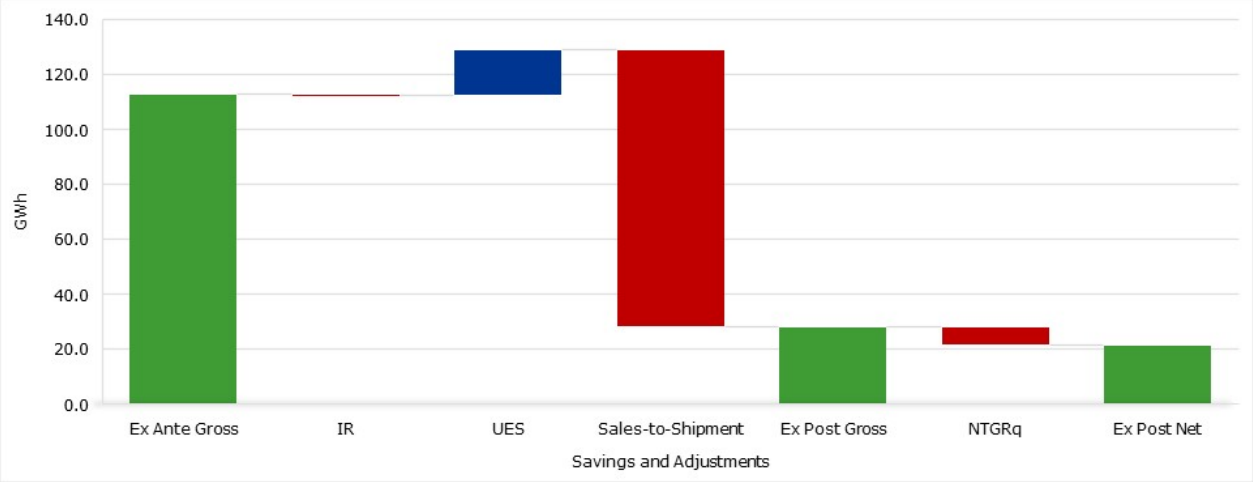


Figure 10-6. Upstream and residential downstream LED Reflectors gross savings waterfall, SDG&E



LED Reflectors

Figure 10-7. Upstream and residential downstream High-Wattage CFLs gross savings waterfall, PG&E

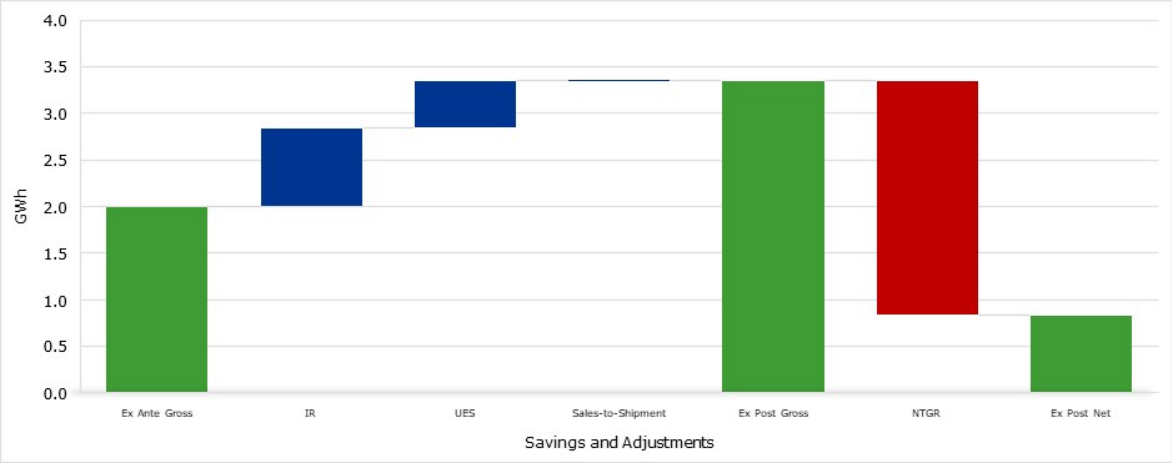


Figure 10-8. Upstream and residential downstream High-Wattage CFLs gross savings waterfall, SCE

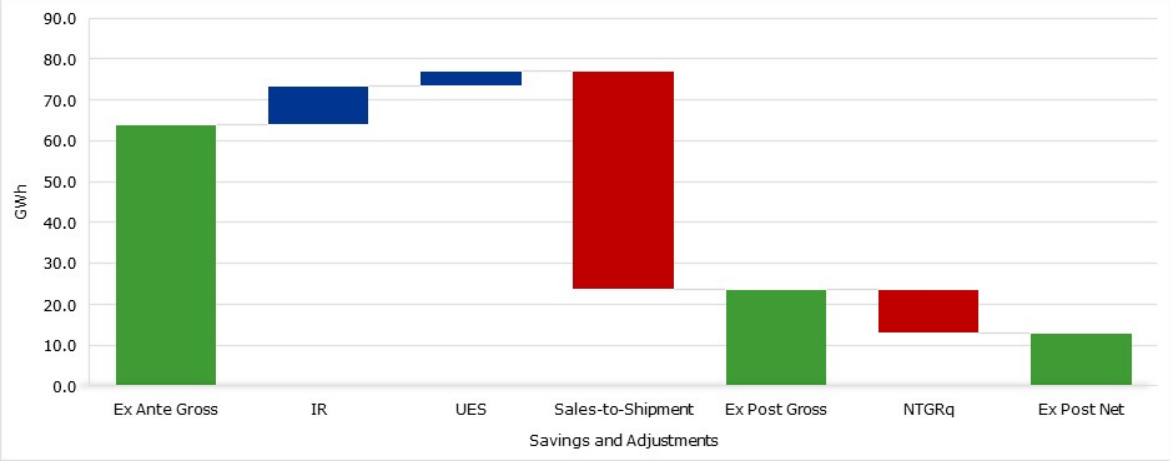
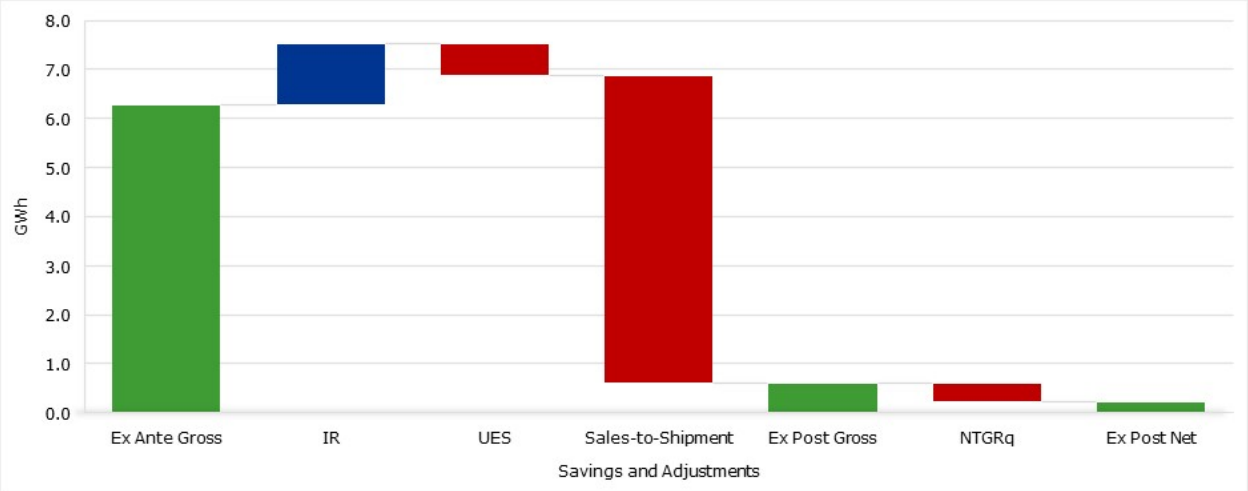
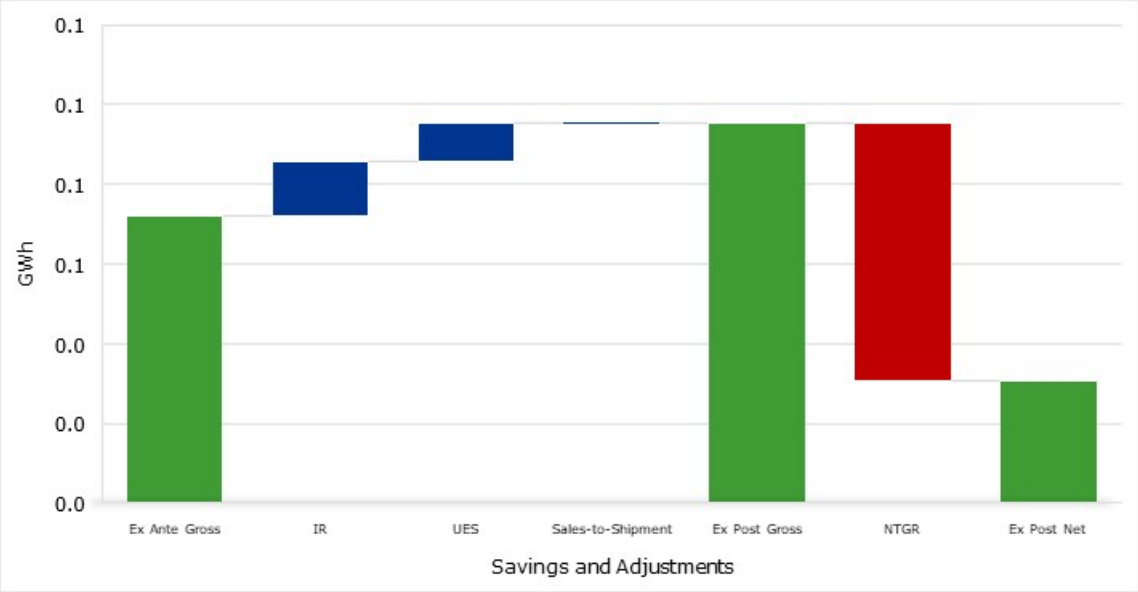


Figure 10-9. Upstream and residential downstream High-Wattage CFLs gross savings waterfall, SDG&E



Basic CFL

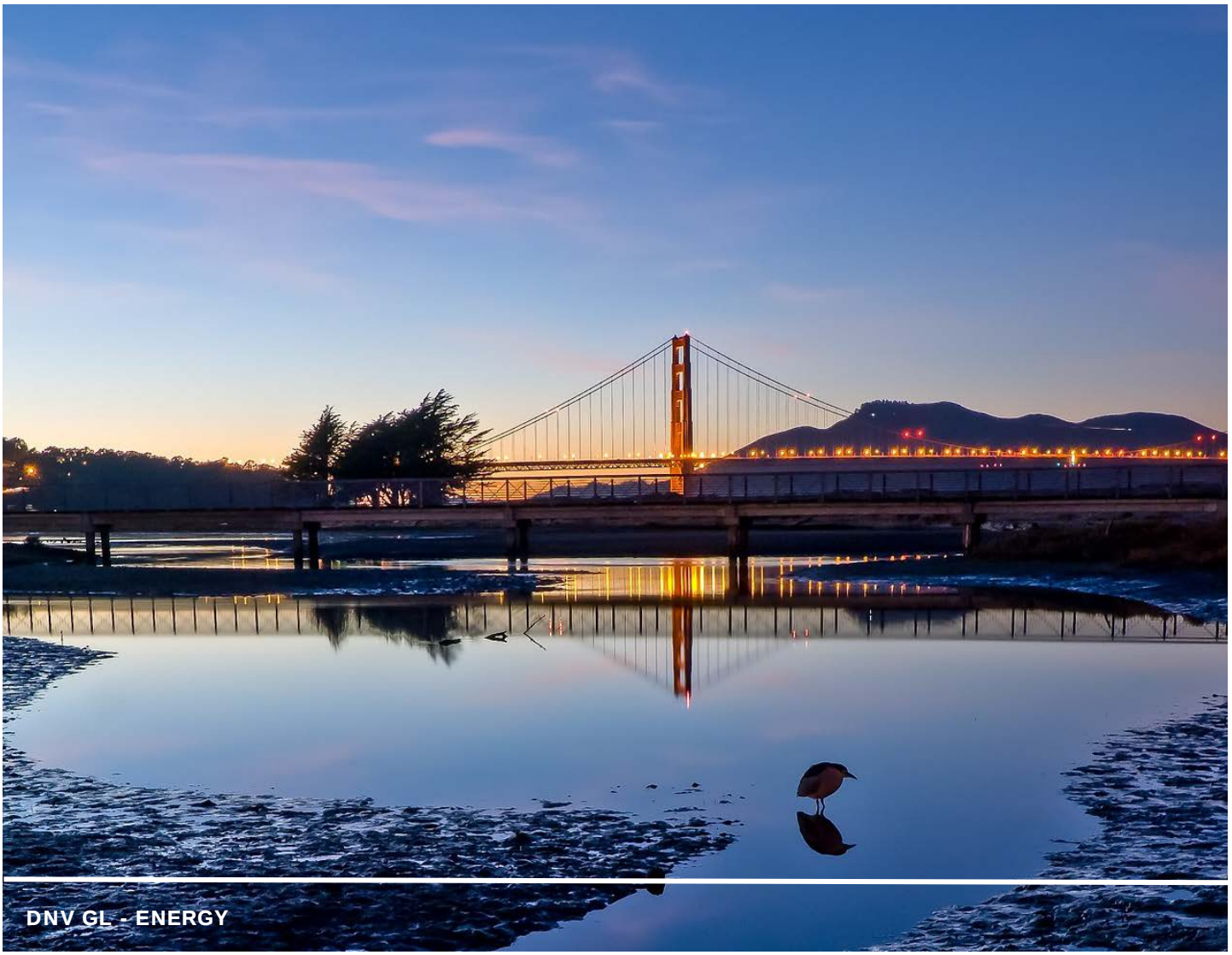
Figure 10-10. Upstream and residential downstream Basic CFL gross savings waterfall, SCE



10.5 Appendix E: Data collection instruments

In this section, we include the lighting retail store telephone survey instrument used to support this evaluation.

DNV·GL



SAFER, SMARTER, GREENER

2017 Upstream Store Manager Survey- FINAL

Lighting Sector

CALIFORNIA PUBLIC UTILITIES COMMISSION

EM&V Group A

JANUARY 29, 2019

1 RESEARCH QUESTIONS

Primary Research Question: What is the estimated lighting sales volume in the independent grocery and discount channels for SCE and SDGE?

Secondary Research Question: What do stores in the independent grocery and discount channels do with overstock of lighting products?

2 SURVEY QUESTIONS

Screener: Hello, is this <STORE NAME>?

Question 1. Does your store sell light bulbs?

Yes [IF YES, GO TO INTRODUCTION]

No/Don't know/Refused [IF NO/DON'T KNOW/REFUSED, GO TO QUESTION 1.1]

Question 1.1. Have you sold light bulbs in the last 3 years? (Yes/No/Don't know/Refused)

[IF NO/DON'T KNOW/REFUSED, TERMINATE SURVEY]

Introduction: Great, I am calling on behalf of the California Public Utilities Commission to research lighting sales in California. [NOTE TO INTERVIEWER: Ask for store manager or owner, if available. Then continue with introduction] Can I ask you a few questions? This will only take a minute or two. [IF NEEDED] This data will not be shared publicly and will be kept confidential. We are conducting this research for the California Public Utilities Commission.

Question 2: By your estimate, how many light bulbs does your store sell in an average week? [NOTE TO INTERVIEWER: Be sure we're getting counts of bulbs sold, not packages of bulbs. If it's easier for the respondent to estimate per day or per month, record and convert sell rate to per week after interview]

Record Answer <NUMBER OF LAMPS SOLD PER WEEK>

Question 3: Thanks. Next I want to ask if you sell some different light bulb technologies?

3.1: Do you sell LED bulbs? (Yes/No/Don't know/Refused)

3.2: Do you sell CFL Bulbs? (Yes/No/Don't know/Refused)

3.3: Do you sell any other types of light bulbs? (Yes/No/Don't know/Refused)

Record answer <OTHER LIGHT BULB TYPES SOLD>

Question 4: Does your store have back stock of light bulbs in storage that are not displayed for sale? (Yes/No/Don't know/Refused)

[CLARIFY IF NEEDED: By storage, I mean any back stock that you have for the lamps that currently aren't on shelves]

Question 5: If you have excess bulbs that you can't sell in a reasonable amount of time, what do you do with them? [PROBE IF NEEDED: Does the store sell overstock? Who do they sell it to?]

Record answer <OPEN ENDED REPONSE> [GO TO CLOSE OUT 1]

Close out 1: Thank you for your answers. Can I please get some clarification on your position at the store?
Record answer <RESPONDENT POSITION: E.g., manager, owner, cashier, etc.>

Close out 2: Can you please provide us with contact information for the store owner?
Record answer <OWNER CONTACT INFORMATION>

End Survey: Great, thank you very much for your time!

10.6 Appendix F: Lamp Choice Model methodology

Overview

Upstream lighting programs use incentives to influence consumer decision-making. The underlying theory is that providing discounts for a CFL or LED lamp makes that CFL or LED lamp a more attractive choice relative to other lamp choices. The question behind this impact evaluation is: what choice would the consumer have made in the absence of the incentive? The program's effects include providing lower-priced lamps in retail stores than would be available without the program, enabling specific retail stores (such as those in the discount channel) to stock lamps than they otherwise would to meet their price point requirements. Discrete choice models are the analytical framework designed to address these types of effects. Discrete choice models combine the relevant information about each possible choice—for example, the lamp price and consumer characteristics—and assign a probability to each of the choices. To answer the impact evaluation question, we use the model to estimate the mix of lamp choices with and without the program in place. The difference is the movement of lamp purchases attributable to the program.

This section presents a summary of the data available for estimation and the estimation results for each of the two lamp replacement categories (A-lamp replacements and reflector lamp replacements) as described in Sections 5.4 and 6.1. For additional background on logit models details on how we developed the lamp choice model, please refer to the CPUC ED 2010-12 California Upstream and Residential Lighting Impact Evaluation Work Order 28 (WO28) Final Report.[49]

Data

Estimating a discrete choice model requires data regarding consumer preferences and their characteristics. DNV GL collected these data with in-store shopper intercept surveys (please see APPENDIX I in the 2015 lighting impact evaluation report[50] for the data collection instrument). The goal of the data collection was to capture the relationships between the choices that consumers make, the prices of lamps available to consumers, and consumer characteristics. Consumers' ranked preferences regarding their lamp choices forms the dependent variables of the logit model. The prices, the retail channels, and customer characteristics are the independent variables.

We collected data regarding characteristics of the intercepted shoppers, the lamp(s) they purchased, and their lamp installation intentions as we expected there would be some correlation between these characteristics and lamp technology preferences. The specific elements we used to construct the lamp choice model include:

- Replaced lamp technology. Our expectation was that technology of the lamp the consumer is replacing can influence the purchase decisions. A consumer who is replacing a CFL, for example, may be more likely to purchase a CFL than a consumer who is replacing an incandescent lamp.
- Annual household income. Our expectation was that price sensitivity would vary by income level. We settled on three household income categories for constructing the lamp choice model: high income ($100,000 or greater), middle or low income (less than $100,000), and unknown/refused.
- Rent versus own. Our expectation was that consumer preferences regarding lamp technologies vary with homeowner status. For example, LED lamps have longer expected lifetimes compared to other

[49] DNV GL 2014c.
[50] DNV GL 2017b.

technologies as well as higher retail prices. Consumers who are more transient (such as renters versus homeowners) may not realize an energy savings payback from LED lamps.

- Planned purchased versus impulse purchase. Our expectation was that the price of the lamp would have greater influence on the decisions of impulse purchasers than on the decisions of shoppers who entered the store planning to purchase a lamp or lamps on the day of the shopper intercept survey.

Estimation approach and results

We estimated separate models for each lamp replacement category (A-lamp replacements and reflector lamp replacements) following the same general approach. We started with simple models and incrementally added complexity to increase the explanatory power of the model and/or to improve the relationships among the model parameters. The general approach is as follows:

1. Establish the fundamental relationship. We designed the model primarily to capture the effect of program price incentives on consumer choice. This model specification, shown in Table 10-1, has alternative-specific constants and generic coefficient on price. The alternative-specific constants force the model to predict market shares that are consistent with market shares in the survey data. The generic price coefficient constrains consumers to have the same price sensitivity toward each alternative technology.

These results meet our a priori expectation that the price coefficient is negative. Consumers prefer lower prices, all other things being equal. Further, we see that consumers are more price-sensitive when shopping for A-lamp replacements than when shopping for reflector lamp replacements. This is consistent with our observation that A-lamps are more of a commodity good than reflector lamps. Manufacturers of reflector lamps compete through a combination of price and unique features. In comparison, A-lamp replacements have fewer distinguishing features and compete mostly on price.

Technical note: we need to fix the value of one alternative-specific constant; this is due to utility values being relative. We have fixed the value of the CFL alternative to zero (the CFL spiral in the case of the A-lamp replacements model).

Table 10-1. Initial estimation results of the A-Lamp replacement model and reflector lamp replacement model, 2015-16

Coefficient	A-lamp Replacements		Reflector Lamp Replacements	
	Estimate	T-Stat	Estimate	T-Stat
Incandescent A-lamp	-1.25	-13.45	0.55	4.51
Halogen A-lamp	-1.22	-12.47	N/A	N/A
CFL spiral				
CFL A-lamp	-1.15	-9.10	N/A	N/A
LED A-lamp	1.34	7.28	1.35	7.67
Price	**-0.24**	**-15.47**	**-0.10**	**-9.03**
Pseudo R2	**0.18**		**0.27**	

2. Refine the model specification. The refinements include:

- Differentiate price-sensitivity by alternative. We let the price coefficients vary by technology. Incandescent, CFL, and LED lamps are not perfect substitutes for each other. LED lamps, for example, have a much longer expected life. Our expectation was that consumers would be most price-sensitive toward incandescent lamps and the least price sensitive toward LED lamps because of differences in the technologies. The result was consistent with our a priori expectations for each model.
- Constrain to channel targets. We constrained the model to match the observed market shares for each alternative by channel. This constraint accounts for the unobserved differences between channels.
- Include customer characteristics. We included customer characteristics in the model to reflect that each retail channel serves different populations. We included four customer characteristics in the models:
    - Income. We stratified the price variable by income level to reflect that consumers with a household income of $100,000 or greater (high income) are less price sensitive than other consumer groups.
    - Planned versus impulse purchases. For the A-lamp replacements model, we stratified the price variable by planned versus impulse purchase. The result was consistent with our expectation that planned purchasers would be less price-sensitive than impulse purchasers. A consumer who visited a store to buy a particular lamp tended to be less price-sensitive than a consumer who decided to buy a lamp when at the store.
    - Replacement lamp technology. The model results supported our expectation that consumers tend not to switch technologies when replacing a lamp.
    - Rent versus own. LED lamps save consumers money over time. However, they have a higher initial cost than other technologies. Consumers who own their homes tend to make longer-term decisions than consumers in rental units. Results in past years suggested that renters were less likely to buy LED lamps than homeowners; however, during this most recent wave, rent versus own was not statistically significant.

Table 10-2 and Table 10-3 show the final model estimations results for A-Lamp replacements and reflector lamp replacements, respectively. Note that the high wattage modeled results simulate high wattage choices using the A-lamp replacement model. The table groups related variables:

- **Alternative-specific constants**. These constants ensure that the total market share for each technology is consistent between model predictions and survey responses.
- **Channel constants**. These constants ensure that the total market share for each technology is consistent between the model predictions and survey responses by retail channel.
- **Price by technology**. These constants reflect the impact of price on utility for each technology.
- **Price / technology interactions by latest wave**. Only A-lamp purchases are in a large enough quantity to control for time, whereas reflectors are limited.
- **Price / income interactions.** We were able to quantify that high-income consumers are less price sensitive than consumers in other groups for A-lamp replacements and reflector replacements. The difference is that the reflector category does not stratify income by lamp technology, whereas the Lamp Choice Model for A-lamps does stratify income by each lamp technology.
- **Pseudo R2**. For each lamp replacement category, the overall fit of the final model shows improvement over the initial results shown in Table 10-1. Pseudo R2 values tend to decrease as the number of

alternatives in the model increases. As there are five alternatives in the A-lamp replacements model, we expected a relatively lower pseudo R2 value.

Table 10-2. Model estimation results for A-lamp replacements, 2015-16

Variable	Estimate	T-Statistic
Alternative-specific constants		
Incandescent A-lamp	-1.43	-8.17
Halogen A-lamp	-1.16	-6.39
CFL spiral		
CFL A-lamp	-1.15	-3.81
LED A-lamp	-0.49	-2.19
Channel constants for incandescent A-lamps		
Discount	1.02	4.19
Drug	-0.09	-0.23
Grocery	1.03	2.05
Hardware	0.33	1.26
Home Improvement	0.42	1.89
Channel constants for halogen A-lamps		
Drug	0.19	0.52
Grocery	1.55	2.73
Hardware	0.32	1.27
Home Improvement	-0.23	-1.14
Channel constants for CFL A-lamps		
Discount	0.66	1.87
Hardware	0.52	1.49
Home Improvement	0.32	0.96
Channel constants for LED A-lamps		
Hardware	1.30	3.97
Home Improvement	1.45	6.03
Price by technology		
Incandescent A-lamp	-0.47	-8.74
Halogen A-lamp	-0.38	-6.50
CFL spiral	-0.31	-14.15
CFL A-lamp	-0.39	-7.68
LED A-lamp	-0.17	-10.98
Price / technology interactions by latest wave		
Incandescent A-lamp	-0.04	-0.38
Halogen A-lamp	0.02	0.27
CFL spiral	-0.02	-0.51
CFL A-lamp	-0.07	-0.97
LED A-lamp	-0.03	-1.54
Price / high income interactions		
High Income	0.06	3.97
Low Income	0.01	0.32
Pseudo R^2	**0.25**	

Table 10-3. Model estimation results for reflector lamp replacements, 2015-16

Variable	Estimate	T-Statistic
Alternative-specific constants		
Incandescent reflector	1.45	4.33
LED reflector	1.18	5.28
Channel constants for incandescent reflectors		
Hardware	-0.45	-1.14
Home improvement	-0.67	-2.37
Channel constants for LED reflectors		
Hardware	-1.14	-2.35
Home improvement	-0.84	-3.08
Price by technology		
Incandescent reflector	-0.22	-7.55
CFL reflector	-0.15	-5.84
LED reflector	-0.10	-7.15
Price / income interactions		
High income	-0.01	-0.25
Unknown income	0.03	2.58
Pseudo R^2		**0.30**

After obtaining the final model coefficients indicated in Table 10-2 and Table 10-3, the team applied these fitted models to three scenarios.

Simulation and scenario analysis methodology

Overview

Although the Lamp Choice Model is interesting and insightful on its own, to add value from the model, it is essential to perform a scenario analysis, via simulations. There are two scenarios we produced from simulations with program and without program that adjusted supply to reflect no program.

Data

Retail lamp stock inventories. DNV GL conducted the most recent phase of stock inventories and shopper intercept surveys during the winter of 2015-16. Field staff spent a minimum of four hours in each store completing the shelf surveys and attempting to intercept shoppers to participate in in-store surveys. Field staff completed surveys opportunistically—that is, with individuals who were shopping during the time periods in which we conducted intercept surveys in specific stores. As such, results from the intercept surveys may not represent the broader population of shoppers purchasing replacement lamps at various stores throughout the year. Nonetheless, given the range in timeframes and store types in which we conducted these surveys, results provide general indications of shopper preferences, price sensitivity, lamp installation intentions, and so on.

The lamp stock inventory sample targeted approximately 200 stores. We stratified the sample by retail channel and PA service territory (for PG&E, SCE, and SDG&E territories) and designed the sample to represent the retail market for residential replacement lamps in these areas. The sample design targeted roughly equal numbers of stores in each retail channel to ensure enough sample points per channel to enable channel-to-channel comparisons.

The LCM reflects the lamp prices and availability that field staff observed in retail stores during the retail stock inventories. We updated the LCM to ensure that it represents the mix of lamp stock found on retail shelves during the winter of 2015-16 shelf inventories. Because we only visit each store on a single day, in-store surveys do not fully capture the year-long availability of program-discounted lamps. We therefore expanded the shelf data to include all 2015 program-discounted lamps. We matched store names in the PA tracking data to store names in the shelf data and used a hedonic model to estimate the program lamp price.[51]

Shopper intercept surveys. In addition to collecting shelf survey data at those stores, field staff administered an in-store survey to shoppers present during the store visit. Because this is a sample of convenience, this survey is not representative of the whole population of lamp shoppers in California during that year. Nevertheless, with the various timeframes and store types where we conducted these surveys, the results are generally indicative of shopper preferences, price sensitivity, lamp installation intentions, and so on. For instance, the surveys were stratified by retail channel and IOU service territory, so the sample can represent the retail market for residential replacement lamps in these areas. Additionally, the sample focused on having a roughly equal number of stores from each channel to ensure enough sample points in each channel to enable channel-to-channel comparisons. Field staff intercepted shoppers who were purchasing replacement lamps and surveyed them on their purchase decisions and installation intentions for

[51] See DNV GL 2016a for further details on the hedonic model.

the lamps being purchased. We conducted over 800 intercept surveys concurrent with the winter of 2014-15 and winter 2015-16 shelf surveys.[52] DNV GL also collected these data in previous evaluation periods.[53]

Program tracking data. Each of the PAs uploads program tracking data onto a centralized server. We use the tracking data to augment the retail lamp stock inventory data and to assign program discounts to the simulations, which we describe in greater detail below.

In-depth telephone interviews with lamp supplier representatives. During the second quarter of 2016, the evaluation team conducted an in-depth survey of lamp suppliers with participating lamp manufacturers. These representatives shared their perspectives on the influences of the upstream lighting program, regulations, standards on California's residential replacement lamp market, as well as numerous other topics. We asked them to predict CFL and LED lighting sales with program discounts available, and one without PA support for CFLs and LED lamps. The 2015 sample frame included 31 manufacturing organizations and the 13 retail chains to which manufacturers shipped the largest shares of total 2013-14 ULP lamps. DNV GL also collected these data in previous evaluation periods.[54]

2016 consumer telephone survey. During October 2016, DNV GL conducted telephone surveys with PG&E, SCE, and SDG&E residential electric customers. These surveys asked consumers how many lamps they purchased within the A-lamp replacement and reflector lamp replacement categories since January 1, 2015, and where they made those purchases. The 2016 consumer telephone survey provided key inputs to generation the simulations. These included:

- **Distribution of lamp purchases by retail channel.** One challenge in using the LCM in previous impact evaluations is that the model relies, in part, on results from the in-store shopper intercept surveys. The intercept surveys are, by necessity, based on a convenience sampling approach. To improve the LCM's ability to represent the distribution of lamp purchases by retail channel within the purchaser population, we included questions in the 2016 consumer telephone surveys to address recent purchase locations (retail channels).
- **Customer demographics together with recent lamp purchase information.** We used the 2016 consumer telephone survey respondents to represent the universe of lamp purchase decisions (rather than intercept survey respondents).

California Lighting Appliance Saturation Study (CLASS). This survey, fielded in 2012 by DNV GL, builds upon previous survey in 2005 and 2000 and consists of stratified random sampling of 1,987 people who live in either single-family, multi-family, or mobile homes with individually metered electric accounts. Teams of field staff traveled to the homes to collect the data. It includes a complete lamp inventory of each home, characteristics of each home, demographics for each respondent, and an appliance inventory. Lamp characteristics include a count of every type of lamp installed and stored, lamp fixture location, lights per fixture, fixture type, lamp technology, lamp wattage, lamp shape, and lamp base type.

The simulation building process

We build LCM simulations based on a series of steps that leverage the data described above. We created three sets of simulations based on the three lamp replacement categories described in the Estimation

[52] Table 3 in California Residential Replacement Lamp Market Status Report (DNV GL 2014b) shows the number of intercept surveys by channel for the last two waves.

[53] Additional information on the results of the intercept surveys can be found in 5.1-5.4 in DNV GL 2014b.

[54] Additional information on the supplier surveys can be found in 4.1 in DNV GL 2014b.

Approach and Results section above (A-lamp replacement, reflector replacement, high wattage replacement). These steps were:

1. **Compile and augment retail lamp stock inventory dataset.** Because we could only collect retail lamp stock data over a single day, we may not have visited participating stores when they were offering discounted lamps. We thus append program lamps from tracking data to the retail lamp stock data sets. This merge is performed when the store name and zip code match between the tracking data and retail lamp stock data. The augmented retail lamp stock inventory dataset then allows us to model a full year's worth of program lamp data (from retail lamp stock inventory data and 2015 program tracking data).
2. **Estimate prices for program lamps that were not observed in stores.** While the 2015 program tracking data provides discount amounts, it does not list the full-retail price of those lamps. We thus used a hedonic model to estimate the retail prices of these augmented lamps.
3. **Identify the quantity and retail locations of lamps purchased in California.** We used 2016 consumer phone surveys to identify the quantity of lamps purchased across different locations. These purchases became the basis for each simulation that we ran through the model. We created 10 simulations for every lamp purchase.
4. **Assign customer demographics to each lamp purchase.** Using the same 2016 survey responses that provided the quantity and location of lamp purchases, we assigned demographic data to these simulations as reported by the survey respondents. These demographic variables included: income, education, number of bedrooms, number of bathrooms, and whether the respondent rented or owned their home.
5. **Estimate the lumen category for each purchased lamp.** While we asked survey respondents to identify the quantity and location of their lamp purchases, we used CLASS data to identify the percentage of installed lamps that fell within 4 lumen bins (where 1 is the lowest lumen and 4 is the highest lumen). We considered the demographics of each respondent and used the frequency that lamps of each lumen bin were installed in homes matching their demographic to select a lumen bin in a probabilistic random fashion. We assigned this lumen bin to the lamp and store purchase simulation.
6. **Select comparable on-shelf lamps to model customer purchase utility and probability.** We referred back to the augmented retail lamp stock inventory data (described in step 1) to build a simulation that represented the survey respondent's lamp purchase. For every simulation, we selected one program lamp from the retail lamp stock inventory data, and any non-program lamps of competing technologies that were available and within the same lumen bin.
7. **Assign with program prices to create simulations that represent a with program universe.** Using the augmented retail lamp stock inventory data, we assigned observed (and hedonically modeled when observed were not available) with program prices. We aggregated all simulations to produce a model universe of lamp purchases that were made in California when program discounts were available.
8. **Remove discounts and adjust lamp availability to create simulations that represent a "without program" universe.** We used the with program simulations but increased the prices of program lamps by the discounts observed in the tracking data. Additionally, we removed program lamps from the simulations when suppliers informed us that they would not have sold those lamps in those respective channels without the program (known in prior evaluations as "reliant" or "constrained")
9. **Adjust membership club availability.** In membership club stores, in the absence of the program, suppliers suggested sales would have been mostly CFLs, and claimed that LED lamps would still have been available. If we did not adjust lamp availability, our model would have no choice but to suggest customers would have purchased LED lamps with and without the program. We thus added CFL

availability to membership club shelves in the "without program" simulations. We retained availability of the LED lamps in these simulations as well. The resulting simulations represent our best estimate of the conditions that would have been observed in the absence of the program.

Two scenarios for the California lighting marketplace

We created two scenarios to estimate the lighting marketplace in California with the program and without the program:

- **With program scenario**. This scenario reflects the lamp prices and availability that field staff observed in retail stores during the retail lamp stock inventories conducted in winter 2015-16. This scenario results in an estimate of the share of program lamp sales for each modeled technology in 2015.
- **Without program scenario.** This scenario reflects the lamp prices as well as stocking changes that consumers would have seen in California retail stores in 2015, if the program had not occurred. We estimated price differences based on matching lamps to program tracking data. This scenario results in a counterfactual estimate of market shares that would have occurred if only prices on program-discounted lamps changed due no program activity. We asked supplier representatives to indicate whether their companies would or would not have sold specific lamp types through specific retail channels in the absence of the program; we considered those lamps to be program-reliant. For example, if a supplier representative told us he or she would not have sold basic spiral CFLs to drug stores without upstream lighting program incentives, we considered the presence of these lamps in drug stores to be program-reliant. In a select number of cases, we use supplier responses to account for additional program influences. This scenario resulted in a counterfactual estimate of market shares if program-reliant lamps were not in stores and if the PAs did not discount lamps.

Net-to-gross from simulation estimates

The lamp choice model estimates with program and without program lamp market shares that feed directly into the NTGRq calculation (Equation 6).

Equation 2. Model-based NTGRq

$$NTGRq = \frac{Program\,Share - No - Program\,Share}{Program\,Share}$$

The NTGRq is the percentage change in market share due to the influence of program activity—that is, the difference between the observed and counterfactual market shares divided by the program market share. For each combination of channel and lamp technology, we evaluated the differences between the "with program" observed scenarios and the "without program" counterfactual scenario.

10.7 Appendix G: Additional tables – gross and net savings

A-lamp lamp replacement category

Table 10-4 presents the average supplier market share estimate for each A-lamp replacement technology with program discounts available and without program lamp discounts available. Because MSB CFL A-lamp ≤ 30 watt lamps, MSB CFL basic spiral ≤ 30 watt lamps, and MSB LED A-lamps are all options within this lamp replacement category, these measure groups displace purchases from one another. This oversimplifies the way the program works in the market in that it does not allow us to disaggregate the influence of the program's incentives for *one measure group at a time* within the lamp replacement category. The supplier estimates present an "all or nothing" perspective—in other words, these estimates suggest the market shares when incentives for all three measure groups are available (the "with program" estimates) versus when incentives for none of the three measure groups are available (the "without program" estimates). Because the impact evaluation must assign savings at the measure group level, we must be able to disaggregate these estimates.

This is the reason that we are unable to combine supplier estimates of market impacts with LCM estimates. However, while the supplier estimates do not feed into the impact calculations, the suppler perspective provides important insights into the overall market influence of the program as a whole (without disaggregating by measure group as required for the impact assessment).

Table 10-4. Supplier-based technology market share estimates for the A-lamp replacement category market (2016 supplier interviews)

Lamp Technology and Shape	Market Share	
	With Program	Without Program
MSB CFL basic spiral ≤ 30 W	22%	35%
MSB CFL A-lamp ≤ 30 W	10%	7%
MSB LED A-lamp, all wattages	51%	29%
MSB incandescent, EISA compliant	12%	17%
MSB incandescent A-lamp	5%	11%
Total affected market	**100%**	**100%**

Reflector lamp replacement category

Table 10-5 displays the average supplier market share estimate for each reflector technology with program discounts available and without program lamp discounts available. Similar to the A-lamp replacement category, we see that CFL reflector lamps ≤ 30 watts would have slightly increased in the absence of the program. This finding is a result of the relative impacts that the two reflector measure groups have against one another.

Table 10-5. Supplier-based technology market share estimates for the reflector replacement category market

Lamp Technology and Shape	Market Share	
	With Program	Without Program
MSB CFL Reflector Lamps ≤ 30 W	36%	38%
MSB LED Reflector Lamps, All Wattages	57%	41%
MSB Halogen Reflector Lamps	5%	8%
MSB Incandescent Reflector Lamps	2%	13%
Total affected market	**100%**	**100%**

High wattage lamp replacement category

Table 10-6 shows the average supplier market share estimate for each high wattage replacement technology with program discounts available and without program lamp discounts available.

Table 10-6. Supplier-based technology market share estimates for the high wattage replacement category market

Lamp Technology and Shape	Market Share	
	With Program	Without Program
MSB high wattage CFL > 30 W	70%	59%
MSB LED A-lamps, high wattage	13%	19%
MSB Halogen A-lamps, high wattage	9%	11%
MSB Incandescent A-lamps, high wattage	8%	11%
Total affected market	100%	100%

Final net savings tables

The following series of tables provide the results that lead to the NTGRq, NTGRu, and overall NTGRs for each measure group.

MSB LED A-lamp, all wattages

Table 10-7. Market shares with and without the program for LED A-lamps

Lamp Technology and Shape	Market Share	
	With Program	Without Program
Discount		
MSB CFL Basic Spiral	18%	33%
MSB CFL A-Lamp	2%	15%
MSB LED A-Lamp	70%	0%
MSB Incandescent, EISA Compliant	0%	0%
MSB Incandescent A-lamp	10%	52%
Drug		
MSB CFL Basic Spiral	46%	52%
MSB CFL A-Lamp	1%	1%
MSB LED A-Lamp	25%	10%
MSB Incandescent, EISA Compliant	16%	20%
MSB Incandescent A-lamp	13%	17%
Grocery		
MSB CFL Basic Spiral	26%	57%
MSB CFL A-Lamp	1%	3%
MSB LED A-Lamp	58%	6%
MSB Incandescent, EISA Compliant	9%	24%
MSB Incandescent A-lamp	6%	10%
Hardware		
MSB CFL Basic Spiral	11%	19%
MSB CFL A-Lamp	1%	2%
MSB LED A-Lamp	70%	49%
MSB Incandescent, EISA Compliant	12%	19%
MSB Incandescent A-lamp	6%	11%
Home improvement		
MSB CFL Basic Spiral	16%	32%
MSB CFL A-Lamp	2%	4%
MSB LED A-Lamp	72%	43%
MSB Incandescent, EISA Compliant	4%	7%
MSB Incandescent A-lamp	7%	15%
Mass merchandise		
MSB CFL Basic Spiral	39%	43%
MSB CFL A-Lamp	2%	2%
MSB LED A-Lamp	27%	17%
MSB Incandescent, EISA Compliant	19%	22%
MSB Incandescent A-lamp	13%	15%
Membership club		
MSB CFL Basic Spiral	27%	67%
MSB CFL A-Lamp	0%	0%
MSB LED A-Lamp	73%	33%
MSB Incandescent, EISA Compliant	0%	0%
MSB Incandescent A-lamp	0%	0%

Table 10-8. Average wattage displaced by program LED A-lamp purchases

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Basic Spiral	21%	22.2	
MSB CFL A-Lamp	18%	20.6	
MSB LED A-Lamp	N/A	N/A	50.8
MSB Incandescent, EISA Compliant	0%	N/A	
MSB Incandescent A-lamp	60%	70.1	
Drug			
MSB CFL Basic Spiral	44%	18.8	
MSB CFL A-Lamp	2%	18.5	
MSB LED A-Lamp	N/A	N/A	36.8
MSB Incandescent, EISA Compliant	29%	53.4	
MSB Incandescent A-lamp	25%	51.2	
Grocery			
MSB CFL Basic Spiral	60%	17.0	
MSB CFL A-Lamp	3%	17.2	
MSB LED A-Lamp	N/A	N/A	28.7
MSB Incandescent, EISA Compliant	29%	48.0	
MSB Incandescent A-lamp	8%	51.5	
Hardware			
MSB CFL Basic Spiral	37%	18.4	
MSB CFL A-Lamp	4%	18.8	
MSB LED A-Lamp	N/A	N/A	38.7
MSB Incandescent, EISA Compliant	33%	48.6	
MSB Incandescent A-lamp	26%	57.6	
Home improvement			
MSB CFL Basic Spiral	55%	16.4	
MSB CFL A-Lamp	5%	14.1	
MSB LED A-Lamp	N/A	N/A	30.8
MSB Incandescent, EISA Compliant	13%	49.1	
MSB Incandescent A-lamp	27%	54.7	
Mass merchandise			
MSB CFL Basic Spiral	48%	14.5	
MSB CFL A-Lamp	4%	15.7	
MSB LED A-Lamp	N/A	N/A	31.7
MSB Incandescent, EISA Compliant	28%	49.1	
MSB Incandescent A-lamp	20%	51.5	
Membership club			
MSB CFL Basic Spiral	100%	17.1	
MSB CFL A-Lamp	0%	N/A	
MSB LED A-Lamp	N/A	N/A	17.1
MSB Incandescent, EISA Compliant	0%	N/A	
MSB Incandescent A-lamp	0%	N/A	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data

Table 10-9. Market delta watts for LED A-lamps

Channel	Average Displaced Wattage (Watts)	Average Program Discounted Wattage (Watts)*	Market Delta Watts
PG&E			
Discount	50.8	10.0	40.8
Drug	36.8		26.8
Grocery	28.7		18.7
Hardware	38.7		28.6
Home improvement	30.8		20.7
Mass merchandise	31.7		21.7
Membership club	17.1		7.1
SCE			
Discount	50.8	9.9	40.9
Drug	36.8		26.9
Grocery	28.7		18.8
Hardware	38.7		28.8
Home improvement	30.8		20.8
Mass merchandise	31.7		21.8
Membership club	17.1		7.2
SDG&E			
Discount	50.8	14.4	36.4
Drug	36.8		22.4
Grocery	28.7		14.3
Hardware	38.7		24.2
Home improvement	30.8		16.3
Mass merchandise	31.7		17.3
Membership club	17.1		2.7

*Source: 2017 program tracking data

Table 10-10. Calculation of LED A-lamps that shifted into membership club due to the program

PA	Program lamps purchased at Membership club*	Program lamps that would have shifted channels without the program		
		Percent of Membership club program purchases that would have occurred elsewhere**	Quantity of lamp purchases that would have occurred elsewhere	Quantity of lamp purchases that would have still occurred at Membership club
PG&E	535,686	50%	267,843	267,843
SCE	927,928		463,964	463,964
SDG&E	198,289		99,144	99,144

*Source: 2017 program tracking data
**Source: 2016 in-depth telephone interviews with lamp suppliers

Table 10-11. Average wattage of lamps that were displaced by channel-shifted program LED A-lamps

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Basic Spiral	33%	22.2	
MSB CFL A-Lamp	15%	20.6	
MSB LED A-Lamp	N/A	N/A	46.9
MSB Incandescent, EISA Compliant	0%	N/A	
MSB Incandescent A-lamp	52%	70.1	
Drug			
MSB CFL Basic Spiral	58%	18.8	
MSB CFL A-Lamp	1%	18.5	
MSB LED A-Lamp	N/A	N/A	32.6
MSB Incandescent, EISA Compliant	22%	53.4	
MSB Incandescent A-lamp	19%	51.2	
Grocery			
MSB CFL Basic Spiral	61%	17.0	
MSB CFL A-Lamp	3%	17.2	
MSB LED A-Lamp	N/A	N/A	28.6
MSB Incandescent, EISA Compliant	26%	48.0	
MSB Incandescent A-lamp	11%	51.5	
Hardware			
MSB CFL Basic Spiral	37%	18.4	
MSB CFL A-Lamp	4%	18.8	
MSB LED A-Lamp	N/A	N/A	38.4
MSB Incandescent, EISA Compliant	37%	48.6	
MSB Incandescent A-lamp	22%	57.6	
Home improvement			
MSB CFL Basic Spiral	55%	16.4	
MSB CFL A-Lamp	7%	14.1	
MSB LED A-Lamp	N/A	N/A	30.2
MSB Incandescent, EISA Compliant	13%	49.1	
MSB Incandescent A-lamp	26%	54.7	
Mass merchandise			
MSB CFL Basic Spiral	52%	14.5	
MSB CFL A-Lamp	3%	15.7	
MSB LED A-Lamp	N/A	N/A	30.4
MSB Incandescent, EISA Compliant	26%	49.1	
MSB Incandescent A-lamp	18%	51.5	
Membership club			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	N/A	N/A	
MSB LED A-Lamp	N/A	N/A	N/A
MSB Incandescent, EISA Compliant	N/A	N/A	
MSB Incandescent A-lamp	N/A	N/A	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data

Table 10-12. Calculation of the overall wattage of lamps that were displaced by channel-shifted program LED A-lamps

Channel	Typical Lamp Purchase Location*	Typical Lamp Purchase Location without displaced channel	Channel-Shifted Quantity NTGR**	Channel-Shifted Displaced Wattage***
Discount	3%	3%	100%	46.9
Drug	3%	3%	90%	32.6
Grocery	3%	3%	94%	28.6
Hardware	9%	10%	51%	38.4
Home improvement	51%	58%	57%	30.2
Mass merchandise	20%	22%	83%	30.4
Membership club	11%			
Total	**100%**	**100%**	**66%**	**31.7**

*Source: 2016 consumer telephone survey
**Source: LCM
***Source: 2015-16 retail lamp stock inventory data

Table 10-13. Unit energy savings and NTGR LED A-lamps

Channel	Count of Sold Program Lamps*	UES (kWh)	UES (kW)	UES (Therms)	NTGR
PG&E					
Discount	168,657	32.3	0.004	(0.771)	100%
Drug	0	-	-	-	0%
Grocery	73,254	14.8	0.002	(0.353)	89%
Hardware	19,801	22.7	0.003	(0.542)	30%
Home improvement	69,105	16.4	0.002	(0.392)	41%
Mass merchandise	14,496	17.2	0.002	(0.410)	34%
Membership club, unshifted counterfactual	267,843	5.6	0.001	(0.134)	54%
Membership club, shifted counterfactual	267,843	17.1	0.002	(0.409)	100%
Other	6,751	16.4	0.002	(0.392)	86%
Total	**887,750**	**16.4**	**0.002**	**(0.392)**	**86%**
SCE					
Discount	422,891	33.4	0.004	(0.617)	100%
Drug	2,304	22.0	0.003	(0.406)	58%
Grocery	227,328	15.3	0.002	(0.284)	89%
Hardware	100,963	23.5	0.003	(0.434)	30%
Home improvement	204,355	17.0	0.002	(0.315)	41%
Mass merchandise	13,900	17.8	0.002	(0.329)	34%
Membership club, unshifted counterfactual	463,964	5.9	0.001	(0.109)	54%
Membership club, shifted counterfactual	0	N/A	N/A	N/A	84%
Other	0	N/A	N/A	N/A	N/A
Total	**1,899,669**	**18.3**	**0.002**	**(0.338)**	**84%**
SDG&E					
Discount	39,867	28.6	0.003	(0.499)	100%
Drug	0	N/A	N/A	N/A	N/A
Grocery	89,438	11.2	0.001	(0.196)	89%
Hardware	94,554	19.0	0.002	(0.333)	30%
Home improvement	161,480	12.8	0.001	(0.224)	41%
Mass merchandise	99,144	2.1	0.000	(0.037)	54%
Membership club, unshifted counterfactual	99,144	13.5	0.002	(0.237)	100%
Membership club, shifted counterfactual	119,352	13.0	0.001	(0.227)	64%
Other	0	N/A	N/A	N/A	N/A
Total	**702,979**	**13.0**	**0.001**	**(0.227)**	**64%**

*Source: 2017 program tracking data
**Standard errors will be provided in the final report

MSB LED reflector, all wattages

Table 10-14. Market shares with and without the program for LED reflector lamps

Lamp Technology and Shape	Market Share	
	With Program	Without Program
Discount		
MSB CFL Reflector	0%	0%
MSB LED Reflector	100%	0%
MSB Halogen Reflector	0%	100%
Drug		
MSB CFL Reflector	0%	0%
MSB LED Reflector	100%	0%
MSB Halogen Reflector	0%	100%
Grocery		
MSB CFL Reflector	0%	0%
MSB LED Reflector	100%	0%
MSB Halogen Reflector	0%	100%
Hardware		
MSB CFL Reflector	6%	6%
MSB LED Reflector	48%	33%
MSB Halogen Reflector	47%	61%
Home improvement		
MSB CFL Reflector	32%	38%
MSB LED Reflector	35%	22%
MSB Halogen Reflector	33%	40%
Mass merchandise		
MSB CFL Reflector	12%	17%
MSB LED Reflector	50%	33%
MSB Halogen Reflector	38%	50%
Membership club		
MSB CFL Reflector	0%	29%
MSB LED Reflector	100%	71%
MSB Halogen Reflector	0%	0%

Table 10-15. Average wattage displaced by program LED reflector purchases

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Reflector	0%	N/A	65.0
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	100%	65.0	
Drug			
MSB CFL Reflector	0%	N/A	59.3
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	100%	59.3	
Grocery			
MSB CFL Reflector	0%	N/A	59.7
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	100%	59.7	
Hardware			
MSB CFL Reflector	3%	21.3	68.2
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	97%	69.7	
Home improvement			
MSB CFL Reflector	48%	17.0	41.8
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	52%	64.4	
Mass merchandise			
MSB CFL Reflector	31%	23.7	51.9
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	69%	64.3	
Membership club			
MSB CFL Reflector	100%	16.0	16.0
MSB LED Reflector	N/A	N/A	
MSB Halogen Reflector	0%	N/A	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data

Table 10-16. Market delta watts for LED reflector lamps

Channel	Average Displaced Wattage (Watts)	Average Program Discounted Wattage (Watts)*	Market Delta Watts
PG&E			
Discount	65.0	7.5	57.5
Drug	59.3		51.8
Grocery	59.7		52.1
Hardware	68.2		60.7
Home improvement	41.8		34.2
Mass merchandise	51.9		44.3
Membership club	16.0		8.5
SCE			
Discount	65.0	9.1	55.9
Drug	59.3		50.2
Grocery	59.7		50.6
Hardware	68.2		59.1
Home improvement	41.8		32.6
Mass merchandise	51.9		42.8
Membership club	16.0		6.9
SDG&E			
Discount	65.0	11.2	53.8
Drug	59.3		48.2
Grocery	59.7		48.5
Hardware	68.2		57.0
Home improvement	41.8		30.6
Mass merchandise	51.9		40.7
Membership club	16.0		4.8

*Source: 2017 program tracking data

Table 10-17. Calculation of LED reflector lamps that shifted into membership club due to the program

PA	Program lamps purchased at Membership club*	Program lamps that would have shifted channels without the program		
		Percent of Membership club program purchases that would have occurred elsewhere**	Quantity of lamp purchases that would have occurred elsewhere	Quantity of lamp purchases that would have still occurred at Membership club
PG&E	579,884	50%	289,942	289,942
SCE	1,244,882		622,441	622,441
SDG&E	395,292		197,646	197,646

*Source: 2017 program tracking data
**Source: 2016 in-depth telephone interviews with lamp suppliers

Table 10-18. Average wattage of lamps that were displaced by channel-shifted program LED reflector lamps

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Reflector	0%	20.7	
MSB LED Reflector	N/A	N/A	65.0
MSB Halogen Reflector	100%	65.0	
Drug			
MSB CFL Reflector	0%	18.6	
MSB LED Reflector	N/A	N/A	59.3
MSB Halogen Reflector	100%	59.3	
Grocery			
MSB CFL Reflector	0%	21.5	
MSB LED Reflector	N/A	N/A	59.7
MSB Halogen Reflector	100%	59.7	
Hardware			
MSB CFL Reflector	9%	21.3	
MSB LED Reflector	N/A	N/A	65.4
MSB Halogen Reflector	91%	69.7	
Home improvement			
MSB CFL Reflector	49%	17.0	
MSB LED Reflector	N/A	N/A	41.3
MSB Halogen Reflector	51%	64.4	
Mass merchandise			
MSB CFL Reflector	25%	23.7	
MSB LED Reflector	N/A	N/A	54.0
MSB Halogen Reflector	75%	64.3	
Membership club			
MSB CFL Reflector	N/A	N/A	
MSB LED Reflector	N/A	N/A	N/A
MSB Halogen Reflector	N/A	N/A	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data

Table 10-19. Calculation of the overall wattage of lamps that were displaced by channel-shifted program LED reflector lamps

Channel	Typical Lamp Purchase Location*	Typical Lamp Purchase Location without displaced channel**	Channel-Shifted Displaced Wattage***
Discount	1%	1%	65.0
Drug	0%	0%	59.3
Grocery	1%	1%	59.7
Hardware	12%	14%	65.4
Home improvement	62%	73%	41.3
Mass merchandise	9%	11%	54.0
Membership club	16%		
Total	**100%**	**100%**	**48.6**

*Source: 2016 consumer telephone survey
**Source: LCM
***Source: 2015-16 retail lamp stock inventory data

Table 10-20. UES and NTGR LED reflectors

Channel	Count of Sold Program Lamps*	UES (kWh)	UES (kW)	UES (Therms)	NTGR
PG&E					
Discount	262,964	45.6	0.006	(1.087)	100%
Drug	0	N/A	N/A	N/A	N/A
Grocery	304,942	41.3	0.005	(0.986)	100%
Hardware	57,732	48.1	0.006	(1.147)	31%
Home improvement	136,789	27.1	0.003	(0.647)	37%
Mass merchandise	23,778	35.2	0.004	(0.839)	33%
Membership club, unshifted counterfactual	289,942	6.7	0.001	(0.160)	29%
Membership club, shifted counterfactual	289,942	32.6	0.004	(0.777)	76%
Other	32,544	31.7	0.004	(0.756)	81%
Total	**1,398,633**	**31.7**	**0.004**	**(0.756)**	**81%**
SCE					
Discount	503,495	45.6	0.006	(0.844)	100%
Drug	118,272	41.0	0.005	(0.758)	100%
Grocery	375,640	41.3	0.005	(0.763)	100%
Hardware	194,912	48.2	0.006	(0.892)	31%
Home improvement	365,542	26.6	0.003	(0.493)	37%
Mass merchandise	0	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual	622,441	5.6	0.001	(0.104)	29%
Membership club, shifted counterfactual	622,441	32.2	0.004	(0.596)	76%
Other	0	30.7	0.004	(0.568)	77%
Total	**2,802,743**	**30.7**	**0.004**	**(0.568)**	**77%**
SDG&E					
Discount	147,462	42.3	0.005	(0.739)	100%
Drug	19,828	37.8	0.004	(0.661)	100%
Grocery	64,911	38.1	0.004	(0.666)	100%
Hardware	99,867	44.8	0.005	(0.783)	31%
Home improvement	128,258	24.0	0.003	(0.420)	37%
Mass merchandise	0	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual	197,646	3.8	0.000	(0.066)	29%
Membership club, shifted counterfactual	197,646	29.4	0.003	(0.514)	76%
Other	87,397	27.5	0.003	(0.481)	71%
Total	**943,015**	**27.5**	**0.003**	**(0.481)**	**71%**

*Source: 2017 program tracking data
**Standard errors will be provided in the final report

MSB CFL high wattage > 30 W

Table 10-21. Market shares with and without the program for high wattage CFLs > 30 W

Lamp Technology and Shape	Market Share	
	With Program	Without Program
Discount		
MSB CFL Basic Spiral	93%	77%
MSB LED lamps	0%	0%
MSB Halogen lamps	0%	0%
MSB Incandescent lamps	7%	23%
Drug		
MSB CFL Basic Spiral	100%	100%
MSB LED lamps	0%	0%
MSB Halogen lamps	0%	0%
MSB Incandescent lamps	0%	0%
Grocery		
MSB CFL Basic Spiral	89%	20%
MSB LED lamps	2%	4%
MSB Halogen lamps	7%	14%
MSB Incandescent lamps	2%	62%
Hardware		
MSB CFL Basic Spiral	11%	4%
MSB LED lamps	0%	0%
MSB Halogen lamps	0%	0%
MSB Incandescent lamps	89%	96%
Home improvement		
MSB CFL Basic Spiral	75%	55%
MSB LED lamps	1%	1%
MSB Halogen lamps	2%	3%
MSB Incandescent lamps	22%	41%
Mass merchandise		
MSB CFL Basic Spiral	70%	44%
MSB LED lamps	4%	8%
MSB Halogen lamps	18%	34%
MSB Incandescent lamps	8%	15%
Membership club		
MSB CFL Basic Spiral	100%	100%
MSB LED lamps	0%	0%
MSB Halogen lamps	0%	0%
MSB Incandescent lamps	0%	0%

Table 10-22. Average wattage displaced by program high wattage CFLs > 30 W purchases

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Basic Spiral	NA	NA	76.4
MSB LED lamps	0%	NA	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	100%	76.4	
Drug			
MSB CFL Basic Spiral	0%	NA	15.5
MSB LED lamps	100%	15.5	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	0%	NA	
Grocery			
MSB CFL Basic Spiral	NA	NA	79.1
MSB LED lamps	3%	13.4	
MSB Halogen lamps	10%	55.4	
MSB Incandescent lamps	87%	83.8	
Hardware			
MSB CFL Basic Spiral	NA	NA	82.1
MSB LED lamps	0%	NA	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	100%	82.1	
Home improvement			
MSB CFL Basic Spiral	NA	NA	79.4
MSB LED lamps	2%	14.8	
MSB Halogen lamps	6%	53.0	
MSB Incandescent lamps	92%	82.3	
Mass merchandise			
MSB CFL Basic Spiral	NA	NA	54.5
MSB LED lamps	14%	14.9	
MSB Halogen lamps	60%	54.5	
MSB Incandescent lamps	26%	75.0	
Membership club			
MSB CFL Basic Spiral	NA	NA	14.6
MSB LED lamps	100%	14.6	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	0%	NA	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data

Table 10-23. Market delta watts for high wattage CFLs > 30 W

Channel	Average Displaced Wattage (Watts)	Average Program Discounted Wattage (Watts)*	Market Delta Watts
PG&E			
Discount	76.4	32.0	44.4
Drug	N/A		N/A
Grocery	79.1		47.1
Hardware	82.1		50.1
Home improvement	79.4		47.4
Mass merchandise	54.5		22.5
Membership club	N/A		N/A
SCE			
Discount	76.4	37.9	38.5
Drug	N/A		N/A
Grocery	79.1		41.2
Hardware	82.1		44.1
Home improvement	79.4		41.5
Mass merchandise	54.5		16.5
Membership club	N/A		N/A
SDG&E			
Discount	76.4	37.9	38.5
Drug	N/A		N/A
Grocery	79.1		41.2
Hardware	82.1		44.2
Home improvement	79.4		41.5
Mass merchandise	54.5		16.6
Membership club	N/A		N/A

*Source: 2017 program tracking data

Table 10-24. Calculation of high wattage CFLs > 30 W that shifted into membership club due to the program

PA	Program lamps purchased at Membership club*	Program lamps that would have shifted channels without the program		
		Percent of Membership club program purchases that would have occurred elsewhere**	Quantity of lamp purchases that would have occurred elsewhere	Quantity of lamp purchases that would have still occurred at Membership club
PG&E	0	50%	0	0
SCE	234,432		117,216	117,216
SDG&E	0		0	0

*Source: 2017 program tracking data
**Source: 2016 in-depth telephone interviews with lamp suppliers

Table 10-25. Average wattage of lamps that were displaced by channel-shifted program high wattage CFLs > 30 W

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Basic Spiral	NA	NA	76.4
MSB LED lamps	0%	NA	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	100%	76.4	
Drug			
MSB CFL Basic Spiral	NA	NA	15.5
MSB LED lamps	100%	15.5	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	0%	NA	
Grocery			
MSB CFL Basic Spiral	NA	NA	75.6
MSB LED lamps	4%	13.4	
MSB Halogen lamps	18%	55.4	
MSB Incandescent lamps	78%	83.8	
Hardware			
MSB CFL Basic Spiral	NA	NA	82.1
MSB LED lamps	0%	NA	
MSB Halogen lamps	0%	NA	
MSB Incandescent lamps	100%	82.1	
Home improvement			
MSB CFL Basic Spiral	NA	NA	79.0
MSB LED lamps	2%	14.8	
MSB Halogen lamps	7%	53.0	
MSB Incandescent lamps	91%	82.3	
Mass merchandise			
MSB CFL Basic Spiral	NA	NA	54.3
MSB LED lamps	14%	14.9	
MSB Halogen lamps	60%	54.5	
MSB Incandescent lamps	26%	75.0	
Membership club			
MSB CFL Basic Spiral	N/A	N/A	N/A
MSB LED lamps	N/A	N/A	
MSB Halogen lamps	N/A	N/A	
MSB Incandescent lamps	N/A	N/A	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data

Table 10-26. Calculation of the overall wattage of lamps that were displaced by channel-shifted program high wattage CFLs > 30 W

Channel	Typical Lamp Purchase Location*	Typical Lamp Purchase Location without displaced channel**	Channel-Shifted Displaced Wattage***
Discount	3%	3%	76.4
Drug	3%	3%	15.5
Grocery	3%	3%	75.6
Hardware	9%	10%	82.1
Home improvement	51%	58%	79.0
Mass merchandise	20%	22%	54.3
Membership club	11%		
Total	**100%**	**100%**	**71.5**

*Source: 2016 consumer telephone survey
**Source: LCM
***Source: 2015-16 retail lamp stock inventory data

Table 10-27. Unit energy savings and NTGR for high wattage CFLs

Channel	Count of Sold Program Lamps*	UES (kWh)	UES (kW)	UES (Therms)	NTGR
PG&E					
Discount	81,000	32.5	0.004	(0.661)	17%
Drug	0	N/A	N/A	N/A	N/A
Grocery	0	N/A	N/A	N/A	N/A
Hardware	0	N/A	N/A	N/A	N/A
Home improvement	0	N/A	N/A	N/A	N/A
Mass merchandise	0	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual	0	N/A	N/A	N/A	N/A
Membership club, shifted counterfactual	0	N/A	N/A	N/A	N/A
Other	0	N/A	N/A	N/A	N/A
Total	**81,000**	**32.5**	**0.004**	**(0.661)**	**17%**
SCE					
Discount	439,167	29.0	0.004	(0.540)	17%
Drug	5,628	(16.9)	(0.002)	0.315	0%
Grocery	255,324	31.0	0.004	(0.578)	78%
Hardware	61,716	33.3	0.004	(0.619)	66%
Home improvement	31,576	31.2	0.004	(0.582)	27%
Mass merchandise	10,275	12.5	0.002	(0.232)	38%
Membership club, unshifted counterfactual	117,216	(17.5)	(0.002)	0.326	0%
Membership club, shifted counterfactual	117,216	25.3	0.003	(0.471)	52%
Other	0	N/A	N/A	N/A	N/A
Total	**1,038,118**	**23.7**	**0.003**	**(0.442)**	**47%**
SDG&E					
Discount	11,780	27.9	0.003	(0.349)	17%
Drug	N/A	N/A	N/A	N/A	N/A
Grocery	2,658	29.9	0.004	(0.373)	78%
Hardware	1,200	32.0	0.004	(0.400)	66%
Home improvement	5,000	30.1	0.004	(0.376)	27%
Mass merchandise	N/A	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual	N/A	N/A	N/A	N/A	N/A
Membership club, shifted counterfactual	N/A	N/A	N/A	N/A	N/A
Other	3,180	29.0	0.003	(0.362)	31%
Total	**23,818**	**29.0**	**0.003**	**(0.362)**	**31%**

*Source: 2017 program tracking data
**Standard errors will be provided in the final report

MSB CFL basic spiral ≤ 30 W

Table 10-28. Market shares with and without the program for CFL basic spiral lamps

Lamp Technology and Shape	Market Share	
	With Program	Without Program
Discount		
MSB CFL Basic Spiral	95%	73%
MSB CFL A-Lamp	0%	0%
MSB LED A-Lamp	0%	0%
MSB Incandescent, EISA Compliant	0%	0%
MSB Incandescent A-lamp	5%	27%
Drug*		
MSB CFL Basic Spiral	N/A	N/A
MSB CFL A-Lamp	N/A	N/A
MSB LED A-Lamp	N/A	N/A
MSB Incandescent, EISA Compliant	N/A	N/A
MSB Incandescent A-lamp	N/A	N/A
Grocery		
MSB CFL Basic Spiral	89%	88%
MSB CFL A-Lamp	3%	2%
MSB LED A-Lamp	3%	4%
MSB Incandescent, EISA Compliant	3%	5%
MSB Incandescent A-lamp	1%	2%
Hardware*		
MSB CFL Basic Spiral	N/A	N/A
MSB CFL A-Lamp	N/A	N/A
MSB LED A-Lamp	N/A	N/A
MSB Incandescent, EISA Compliant	N/A	N/A
MSB Incandescent A-lamp	N/A	N/A
Home improvement		
MSB CFL Basic Spiral	37%	21%
MSB CFL A-Lamp	8%	8%
MSB LED A-Lamp	36%	38%
MSB Incandescent, EISA Compliant	5%	6%
MSB Incandescent A-lamp	14%	28%
Mass merchandise		
MSB CFL Basic Spiral	53%	44%
MSB CFL A-Lamp	0%	0%
MSB LED A-Lamp	6%	8%
MSB Incandescent, EISA Compliant	27%	33%
MSB Incandescent A-lamp	13%	15%
Membership club		
MSB CFL Basic Spiral	78%	58%
MSB CFL A-Lamp	0%	0%
MSB LED A-Lamp	22%	42%
MSB Incandescent, EISA Compliant	0%	0%
MSB Incandescent A-lamp	0%	0%

*We did not model these channels because the program did not ship lamps to them.

Table 10-29. Average wattage displaced by program CFL basic spiral purchases

Lamp Technology and Shape	Percent of Displaced Market Share*	Average Wattage on Shelf**	Average Displaced Wattage
Discount			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	0%	N/A	
MSB LED A-Lamp	0%	N/A	70.1
MSB Incandescent, EISA Compliant	0%	N/A	
MSB Incandescent A-lamp	100%	70.1	
Drug* **			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	N/A	N/A	
MSB LED A-Lamp	N/A	N/A	N/A
MSB Incandescent, EISA Compliant	N/A	N/A	
MSB Incandescent A-lamp	N/A	N/A	
Grocery			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	0%	N/A	
MSB LED A-Lamp	31%	9.9	36.9
MSB Incandescent, EISA Compliant	51%	48.0	
MSB Incandescent A-lamp	18%	51.5	
Hardware* **			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	N/A	N/A	
MSB LED A-Lamp	N/A	N/A	N/A
MSB Incandescent, EISA Compliant	N/A	N/A	
MSB Incandescent A-lamp	N/A	N/A	
Home improvement			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	1%	14.1	
MSB LED A-Lamp	11%	9.2	49.1
MSB Incandescent, EISA Compliant	3%	49.1	
MSB Incandescent A-lamp	85%	54.7	
Mass merchandise			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	0%	N/A	
MSB LED A-Lamp	16%	10.4	43.7
MSB Incandescent, EISA Compliant	59%	49.1	
MSB Incandescent A-lamp	26%	51.5	
Membership club			
MSB CFL Basic Spiral	N/A	N/A	
MSB CFL A-Lamp	0%	N/A	
MSB LED A-Lamp	100%	9.4	9.4
MSB Incandescent, EISA Compliant	0%	N/A	
MSB Incandescent A-lamp	0%	N/A	

*Source: LCM
**Source: 2015-2016 retail lamp stock inventory data
***We did not model these channels because the program did not ship lamps to them.

Table 10-30. Market delta watts for CFL basic spiral

Channel	Average Displaced Wattage (Watts)	Average Program Discounted Wattage (Watts)*	Market Delta Watts
PG&E			
Discount	N/A		N/A
Drug**	N/A		N/A
Grocery	N/A		N/A
Hardware**	N/A	N/A	N/A
Home improvement	N/A		N/A
Mass merchandise	N/A		N/A
Membership club	N/A		N/A
SCE			
Discount	70.1		45.9
Drug**	N/A		N/A
Grocery	36.9		12.7
Hardware**	N/A	24.2	N/A
Home improvement	N/A		N/A
Mass merchandise	N/A		N/A
Membership club	N/A		N/A
SDG&E			
Discount	N/A		N/A
Drug**	N/A		N/A
Grocery	N/A		N/A
Hardware**	N/A	N/A	N/A
Home improvement	N/A		N/A
Mass merchandise	N/A		N/A
Membership club	N/A		N/A

*Source: 2017 program tracking data
**We did not model these channels because the program did not ship lamps to them.

Table 10-31. Calculation of CFL basic spiral lamps that shifted into membership club due to the program

PA	Program lamps purchased at Membership club*	Program lamps that would have shifted channels without the program		
		Percent of Membership club program purchases that would have occurred elsewhere**	Quantity of lamp purchases that would have occurred elsewhere	Quantity of lamp purchases that would have still occurred at Membership club
PG&E	0	N/A	N/A	N/A
SCE	0		N/A	N/A
SDG&E	0		N/A	N/A

*Source: 2017 program tracking data
**Source: 2016 in-depth telephone interviews with lamp suppliers

Table 10-32. Unit energy savings and NTGR, CFL basic spiral

Channel	Count of Sold Program Lamps*	UES (kWh)	UES (kW)	UES (Therms)	NTGR
PG&E					
Discount**	0	N/A	N/A	N/A	N/A
Drug**	0	N/A	N/A	N/A	N/A
Grocery**	0	N/A	N/A	N/A	N/A
Hardware**	0	N/A	N/A	N/A	N/A
Home improvement**	0	N/A	N/A	N/A	N/A
Mass merchandise**	0	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual**	0	N/A	N/A	N/A	N/A
Membership club, shifted counterfactual**	0	N/A	N/A	N/A	N/A
Other	0	N/A	N/A	N/A	N/A
Total	**0**	**N/A**	**N/A**	**N/A**	**N/A**
SCE					
Discount	1,800	34.79	0.0048	(0.64)	N/A
Drug**	0	N/A	N/A	N/A	N/A
Grocery	3,089	9.63	0.0013	(0.18)	N/A
Hardware**	0	N/A	N/A	N/A	N/A
Home improvement**	0	N/A	N/A	N/A	N/A
Mass merchandise**	0	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual**	0	N/A	N/A	N/A	N/A
Membership club, shifted counterfactual**	0	N/A	N/A	N/A	N/A

Other**	0	N/A	N/A	N/A	N/A
Total	**4,889**	**18.9**	**0.003**	**(0.350)**	**17%**
SDG&E					
Discount***	0	N/A	N/A	N/A	N/A
Drug***	0	N/A	N/A	N/A	N/A
Grocery***	0	N/A	N/A	N/A	N/A
Hardware***	0	N/A	N/A	N/A	N/A
Home improvement***	0	N/A	N/A	N/A	N/A
Mass merchandise***	0	N/A	N/A	N/A	N/A
Membership club, unshifted counterfactual***	0	N/A	N/A	N/A	N/A
Membership club, shifted counterfactual***	0	N/A	N/A	N/A	N/A
Other***	0	N/A	N/A	N/A	N/A
Total	**0**	**N/A**	**N/A**	**N/A**	**N/A**

*Source: 2017 program tracking data
**Standard errors will be provided in the final report
***We did not model these channels because the program did not ship lamps to them.

Table 10-33. Unit energy savings and NTGR with standard errors

Channel	UES (kWh)	SE	UES (kW)	SE	UES (Therms)	SE	NTGR	SE
PG&E								
LED A-lamps	16.43	1.51	0.002	0.0002	-0.39	0.036	0.86	0.024
LED Reflectors	31.7	1.94	0.004	0.0002	-0.76	0.046	0.81	0.045
High-Wattage CFLs	32.5	0.24	0.004	0.00003	-0.66	0.0044	0.17	0.063
SCE								
LED A-lamps	18.26	1.65	0.002	0.0002	-0.34	0.030	0.84	0.028
LED Reflectors	30.7	2.20	0.004	0.0003	-0.57	0.041	0.77	0.050
Basic CFLs	18.9	4.07	0.003	0.0006	-0.35	0.075	0.17	0.054
High-Wattage CFLs	23.7	0.24	0.003	0.00003	-0.44	0.0044	0.47	0.27
SDG&E								
LED A-lamps	12.97	2.09	0.002	0.0002	-0.23	0.037	0.64	0.053
LED Reflectors	27.5	2.31	0.003	0.0003	-0.48	0.040	0.71	0.061
High-Wattage CFLs	29.0	0.09	0.003	0.00001	-0.36	0.0011	0.31	0.17

10.8 Appendix H: CREED sales data

Introduction

Developed by Apex Analytics, the Consortium for Retail Energy Efficiency Data (CREED) serves as a consortium of PAs, retailers, and manufacturers working together to collect the necessary data to better plan and evaluate energy efficiency programs.[55] LightTracker is CREED's first initiative, focused on acquiring full-category lighting data, including incandescent, halogen, CFL, and LED bulb types, for all distribution channels in the entire United States. As a consortium, CREED speaks as one voice for PAs nationwide as they request, collect, and report on the sales data needed by the energy efficiency community. The Full Category Sales report (LightTracker) created by CREED relies on many data sources. There are two primary data sources which are purchased from data vendors (Nielsen and IRI), and secondary data available publicly from different sources (see below). The Point-of-Sale (POS) dataset is used to report actual scanned sales from available retailers, and the Panel dataset is used to fill-in the remaining retailers' sales estimates.

Proprietary data sources

POS dataset

The POS dataset includes lighting sales data for grocery, drug, dollar, discount, and mass merchandiser distribution channels. These data represent actual sales that are scanned at the cash register for participating retailers. Since there are a larger number of smaller chains and independent locations within the grocery channel, the data vendors have defined the grocery channel to stores that do over $2 million annually in sales, meaning the smallest locations are omitted from the dataset.[56] The raw data is aggregated at the state level and is reported at a product-level. For example, the dataset provides the number of units of a specific UPC purchased in any given state in the calendar year.

Panel dataset

The Panel data represent the remaining retail channels, including home improvement, club, hardware, online, and smaller grocery/bodega stores (not included in the POS). The Panel data are largely derived from the National Consumer Panel (NCP), which represents a panel of approximately 100,000 residential households – including over 6,000 in California – that are provided a handheld scanner for their homes and instructed to scan every purchase they make that has a bar code. The use of a scanner avoids potential "recall bias," which is prevalent in self-report methods that ask about lighting purchases. The NCP data is aggregated at the state-level and at a category of bulb type-level (e.g., the total number of LEDs purchased in California).

Combining the datasets

The Apex team combines the POS and panel data, and then verifies and calibrates (as needed) based on additional secondary data sources, including:

- U.S. Census Bureau import data (CFL and LED imports)
- ENERGY STAR shipment data (released by the U.S. Environmental Protection Agency)
- North American Electrical Manufacturers Association shipment data
- General population surveys, lighting saturation studies, and other secondary data collection made publicly available through evaluation reports

[55] For further details on CREED, please see https://www.creedlighttracker.com/

[56] CREED addresses the omission of these smaller, independent grocery stores by capturing the estimated sales in the Panel dataset.

Data cleaning

Although the dataset includes detailed records of lighting data purchases, the Apex team devotes a considerable effort to ensure data integrity and inclusion of all the necessary bulb attributes. For example, not all records were populated with some of the more critical variables such as bulb type, style, and wattage or the data had clearly erroneous values (e.g., 60-watt LEDs).

After thorough review and quality control of the dataset, the Apex team reclassified, standardized, and populated missing records, created additional variables, and performed general enhancements to the data. To populate missing records, validate existing records, and include additional bulb attributes, the Apex Team created a proprietary Universal Product Code (UPC) database with approximately 36,000 bulbs from five sources:

- Manufacturer product databases provided to LightTracker
- Product catalogs downloaded from manufacturer web sites via Python-based web scraping
- Product offerings downloaded from retailer websites
- Automated lookups of online UPC databases (such as www.upcitemdb.com)
- ENERGY STAR databases available online (such as https://www.energystar.gov/productfinder/product/certified-light-bulbs)

LightTracker then merged the bulb database with the POS/Panel data, populating fields based on a hierarchy of data sources believed to be most reliable. Prioritization was typically based in the following order: manufacturer specifications, UPC lookups, original data provider (IRI and Nielsen) database values. The Apex team also conducted manual web lookups on individual bulbs to determine final assignments.

In addition, the Apex team investigated the bulb assignment and the quantity of bulbs per package by examining the average price per unit and identifying outliers in terms of per bulb prices. This process helped us identify misclassification of certain bulb types (e.g., bulbs that were flagged as low-cost LEDs but were really LED nightlights, so needed to be moved under “other”), as well as bulb counts that represented box shipments (e.g., a package identified as having 36 bulbs was really a six-pack of LEDs that was shipped with six packages per box). The sales model is restricted to screw-based bulbs, so any bulbs classified as type “other” were not included in the model.

2017 California lamp sales

Apex Analytics compiled CREED sales data for California in 2017. The sales data included point of sales (POS) data for select retailers from discount, drug, grocery, mass merchandise, and select membership club channels (POS estimate). The data also included a panel estimate of sales from other channels in the market, which included home improvement, hardware, remaining stores not included in the POS dataset, and online stores (non-POS estimate). Table 10-34 shows a breakdown of total lamp sales in California by technology and lamp shape for the POS and non-POS estimates as well as the combined total sales from the POS and non-POS datasets.

Table 10-34. California replacement lamp sales estimates, 2017

Technology	Lamp Shape	POS Estimate	Non-POS Estimate	Total CA Sales
CFL	Greater than 30W	105,567	11,160,520	11,922,276
	All other CFL	656,189		
LED	A lamp	6,198,713	42,069,024	49,448,445
	Reflector	737,942		

Technology	Lamp Shape	POS Estimate	Non-POS Estimate	Total CA Sales
	All other LED	442,765		
Halogen	All halogen	9,436,167	39,499,744	48,935,911
Incandescent	All incandescent	8,494,917	4,230,210	12,725,127
Total Sales		26,072,261	96,959,498	123,031,759

Table 10-35 shows POS sales estimates for the San Francisco metro area. Panel estimates were not available for metro area lamp sales.

Table 10-35. San Francisco metro area replacement sales estimates, 2017[57]

Technology	Lamp Shape	POS Sales
CFL	Greater than 30W	154
	All other CFL	85,465
LED	A lamp	653,909
	Reflector	87,014
	All other LED	369,644
Halogen	All halogen	1,934,924
Incandescent	All incandescent	1,407,798
Total Sales		4,538,909

Table 10-36 shows POS sales estimates for the Sacramento metro area.

Table 10-36. Sacramento metro area replacement sales estimates, 2017[58]

Technology	Lamp Shape	POS Sales
CFL	Greater than 30W	589
	All other CFL	57,661
LED	A lamp	667,614
	Reflector	73,584
	All other LED	317,406
Halogen	All halogen	1,204,704
Incandescent	All incandescent	1,148,380
Total Sales		3,469,938

Table 10-37 shows POS sales estimates for the Los Angeles metro area.

Table 10-37. Los Angeles metro area replacement lamp sales estimates, 2017[59]

Technology	Lamp Shape	POS Sales
CFL	Greater than 30W	100,344
	All other CFL	392,736
LED	A lamp	1,973,596

[57] Includes Alameda, Contra Costa, Lake, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties.

[58] Includes Alpine, Amador, Calaveras, Colusa, El Dorado, Mono, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Stanislaus, Sutter, Tuolumne, Yolo, and Yuba counties.

[59] Includes Los Angeles, Orange, Riverside, and San Bernardino counties.

Technology	Lamp Shape	POS Sales
	Reflector	241,562
	All other LED	1,076,271
Halogen	All halogen	3,817,032
Incandescent	All incandescent	3,663,660
Total Sales		11,265,201

Table 10-38 shows the list of retailers that were included in the POS dataset.

Table 10-38. List of participating retailers (provided by Nielsen), 2017

Retailer	Channel
AAFES Exchanges	Mass Merchandise
Albertsons	Grocery
Ampm	Convenience Store
Big Kmart	Mass Merchandise
CVS Pharmacy	Drug
Cardenas Market	Grocery
DECA Barstow MCLB Commissary	Grocery
DECA China Lake NAWS Commissary	Grocery
DECA Los Angeles AFB Commissary	Grocery
Dollar General	Mass Merchandise
El Super	Grocery
Family Dollar	Mass Merchandise
Lucky Store	Grocery
Marine Corps Exchange	Mass Merchandise
Navy Exchange	Mass Merchandise
Pavilions	Grocery
Rite Aid	Drug
Sam's Club	Membership Club
Save Mart	Grocery
Stater Bros	Grocery
SuperTarget Center	Grocery
Target Store	Mass Merchandise
The Market by Vons	Grocery
Vons Food & Drug	Grocery
Vons Market	Grocery
Walgreens	Drug
Walmart Neighborhood Mkt	Grocery
Walmart Store	Mass Merchandise
Walmart Supercenter	Grocery
Whole Foods Market	Grocery

10.9 Appendix I: Lighting retail-store telephone survey results

In this section, we present the results of the 2019 store manager survey results. From late January to early February 2019, the evaluation team conducted telephone surveys with grocery and discount stores in SCE and SDG&E service territories that received shipments of PA-discounted lamps in 2017. For further details on the targeted versus completed surveys as well as research objectives, please see Section 3.3. To view the survey instrument, please see Appendix E. For information on estimated annual lamp sales by PA and channel, please see Section 4.1.5.[60] For the full dataset of anonymized survey results, please see the Excel file entitled "Final Clean 2019 Retail Store Phone Survey Results_Anonymous" that was posted with this report.

Lamp sales

Interviewers asked respondents whether their store sells light bulbs. Table 10-39 shows the number of stores that sell light bulbs by PA and channel.

Table 10-39. Number of stores that sell light bulbs by PA and channel, 2019

PA	Channel	Sell light bulbs	Don't sell light bulbs	Total
SCE	CHAIN DISCOUNT	13	1	14
	CHAIN GROCERY	4	5	9
	IND DISCOUNT	3	2	5
	IND GROCERY	3	3	6
	SCE Total	**23**	**11**	**34**
SDG&E	CHAIN DISCOUNT	13	2	15
	CHAIN GROCERY	4	1	5
	IND DISCOUNT	8	3	11
	IND GROCERY	12	6	18
	SDG&E Total	**37**	**12**	**49**
Overall		**60**	**23**	**83**

Table 10-40 shows the weighted percent of stores that sell light bulbs by PA and channel.

Table 10-40. Percent of stores that sell light bulbs by PA and channel, 2019

PA	Channel	Sell light bulbs	Don't sell light bulbs	Total
SCE	CHAIN DISCOUNT	93%	7%	100%
	CHAIN GROCERY	44%	56%	100%
	IND DISCOUNT	60%	40%	100%

[60] Sales estimates were derived from question 2 of the lighting retail store telephone survey: "By your estimate, how many light bulbs does your store sell in an average week?"

PA	Channel	Sell light bulbs	Don't sell light bulbs	Total
	IND GROCERY	50%	50%	100%
	SCE Total	**65%**	**35%**	**100%**
SDG&E	CHAIN DISCOUNT	87%	13%	100%
	CHAIN GROCERY	80%	20%	100%
	IND DISCOUNT	73%	27%	100%
	IND GROCERY	67%	33%	100%
	SDG&E Total	**70%**	**30%**	**100%**
	Overall	**66%**	**34%**	**100%**

Interviewers asked those survey respondents who said that their store currently does not sell light bulbs whether their store has sold light bulbs in the past 3 years. Table 10-41 shows the number of respondents who said that their stores have sold light bulbs in the past 3 years.

Table 10-41. Number of stores that have sold light bulbs in past 3 years by PA and channel, 2019

PA	Channel	Have sold light bulbs	Have not sold light bulbs	Total
SCE	CHAIN DISCOUNT	0	1	1
	CHAIN GROCERY	0	5	5
	IND DISCOUNT	0	2	2
	IND GROCERY	0	3	3
	SCE Total	**0**	**11**	**11**
SDG&E	CHAIN DISCOUNT	1	1	2
	CHAIN GROCERY	0	1	1
	IND DISCOUNT	2	1	3
	IND GROCERY	0	6	6
	SDG&E Total	**3**	**9**	**12**
	Overall	**3**	**20**	**23**

Table 10-42 shows the weighted percent of stores that have sold light bulbs in the past 3 years by PA and channel.

Table 10-42. Percent of stores that have sold light bulbs in past 3 years by PA and channel, 2019

PA	Channel	Have sold light bulbs	Have not sold light bulbs	Total
SCE	CHAIN DISCOUNT	0%	100%	100%

PA	Channel	Have sold light bulbs	Have not sold light bulbs	Total
	CHAIN GROCERY	0%	100%	100%
	IND DISCOUNT	0%	100%	100%
	IND GROCERY	0%	100%	100%
	SCE Total	**0%**	**100%**	**100%**
SDG&E	CHAIN DISCOUNT	50%	50%	100%
	CHAIN GROCERY	0%	100%	100%
	IND DISCOUNT	67%	33%	100%
	IND GROCERY	0%	100%	100%
	SDG&E Total	**8%**	**92%**	**100%**
Overall		**2%**	**98%**	**100%**

Lamp sales by lamp type

Interviewers asked respondents what type of light bulbs they sell or have sold in the past 3 years. Table 10-43 shows the number of stores that sell LEDs by PA and channel.

Table 10-43. Number of stores that sell LEDs by PA and channel, 2019

PA	Channel	Sell LEDs	Don't sell LEDs	Don't know	Refused	Total
SCE	CHAIN DISCOUNT	11	2	0	0	13
	CHAIN GROCERY	4	0	0	0	4
	IND DISCOUNT	3	0	0	0	3
	IND GROCERY	3	0	0	0	3
	SCE Total	**21**	**2**	**0**	**0**	**23**
SDG&E	CHAIN DISCOUNT	9	0	1	4	14
	CHAIN GROCERY	4	0	0	0	4
	IND DISCOUNT	9	1	0	0	10
	IND GROCERY	7	0	5	0	12
	SDG&E Total	**29**	**1**	**6**	**4**	**40**
Overall		**50**	**3**	**6**	**4**	**63**

Table 10-44 shows the weighted percent of stores that sell LEDs by PA and channel.

Table 10-44. Percent of stores that sell LEDs by PA and channel, 2019

PA	Channel	Sell LEDs	Don't sell LEDs	Don't know	Refused	Total
SCE	CHAIN DISCOUNT	85%	15%	0%	0%	100%
	CHAIN GROCERY	100%	0%	0%	0%	100%
	IND DISCOUNT	100%	0%	0%	0%	100%
	IND GROCERY	100%	0%	0%	0%	100%
	SCE Total	**93%**	**7%**	**0%**	**0%**	**100%**
SDG&E	CHAIN DISCOUNT	64%	0%	7%	29%	100%
	CHAIN GROCERY	100%	0%	0%	0%	100%
	IND DISCOUNT	90%	10%	0%	0%	100%
	IND GROCERY	58%	0%	42%	0%	100%
	SDG&E Total	**64%**	**1%**	**31%**	**4%**	**100%**
Overall		**83%**	**5%**	**10%**	**1%**	**100%**

Table 10-45 shows the number of stores that sell CFLs by PA and channel.

Table 10-45. Number of stores that sell CFLs by PA and channel, 2019

PA	Channel	Sell CFLs	Don't sell CFLs	Don't know	Refused	Total
SCE	CHAIN DISCOUNT	5	4	4	0	13
	CHAIN GROCERY	3	0	1	0	4
	IND DISCOUNT	3	0	0	0	3
	IND GROCERY	1	1	1	0	3
	SCE Total	**12**	**5**	**6**	**0**	**23**
SDG&E	CHAIN DISCOUNT	7	1	2	4	14
	CHAIN GROCERY	3	0	1	0	4
	IND DISCOUNT	2	7	0	0	9
	IND GROCERY	4	0	8	0	12
	SDG&E Total	**16**	**8**	**11**	**4**	**39**
Overall		**28**	**13**	**17**	**4**	**62**

Table 10-46 shows the weighted percent of stores that sell CFLs by PA and channel.

Table 10-46. Percent of stores that sell CFLs by PA and channel, 2019

PA	Channel	Sell CFLs	Don't sell CFLs	Don't know	Refused	Total
SCE	CHAIN DISCOUNT	38%	31%	31%	0%	100%
	CHAIN GROCERY	75%	0%	25%	0%	100%
	IND DISCOUNT	100%	0%	0%	0%	100%
	IND GROCERY	33%	33%	33%	0%	100%
	SCE Total	**50%**	**24%**	**26%**	**0%**	**100%**
SDG&E	CHAIN DISCOUNT	50%	7%	14%	29%	100%
	CHAIN GROCERY	75%	0%	25%	0%	100%
	IND DISCOUNT	22%	78%	0%	0%	100%
	IND GROCERY	33%	0%	67%	0%	100%
	SDG&E Total	**36%**	**9%**	**51%**	**4%**	**100%**
Overall		**46%**	**19%**	**35%**	**1%**	**100%**

Table 10-47 shows the number of stores that sell other lamp technologies by PA and channel.

Table 10-47. Number of stores that sell other lamp technologies by PA and channel, 2019

PA	Channel	Sell incandescent lamps	Sell other technology (not specified)	Don't sell other technology	Don't know	Refused	Total
SCE	CHAIN DISCOUNT	0	5	4	0	0	9
	CHAIN GROCERY	0	0	4	0	0	4
	IND DISCOUNT	1	1	1	0	0	3
	IND GROCERY	0	1	2	0	0	3
	SCE Total	**1**	**7**	**11**	**0**	**0**	**19**
SDG&E	CHAIN DISCOUNT	0	9	2	2	1	14
	CHAIN GROCERY	0	2	1	1	0	4
	IND DISCOUNT	5	0	1	2	0	8
	IND GROCERY	0	2	6	3	1	12
	SDG&E Total	**5**	**13**	**10**	**8**	**2**	**38**
Overall		**6**	**20**	**21**	**8**	**2**	**57**

Table 10-48 shows the weighted percent of stores that sell other lamp technologies by PA and channel.

Table 10-48. Percent of stores that sell other lamp technologies by PA and channel, 2019

PA	Channel	Sell incandescent lamps	Sell other technology (not specified)	Don't sell other technology	Don't know	Refused	Total
SCE	CHAIN DISCOUNT	0%	56%	44%	0%	0%	100%
	CHAIN GROCERY	0%	0%	100%	0%	0%	100%
	IND DISCOUNT	33%	33%	33%	0%	0%	100%
	IND GROCERY	0%	33%	67%	0%	0%	100%
	SCE Total	**6%**	**38%**	**56%**	**0%**	**0%**	**100%**
SDG&E	CHAIN DISCOUNT	0%	64%	14%	14%	7%	100%
	CHAIN GROCERY	0%	50%	25%	25%	23%	100%
	IND DISCOUNT	63%	0%	13%	25%	10%	100%
	IND GROCERY	0%	17%	50%	25%	8%	100%
	SDG&E Total	**6%**	**23%**	**41%**	**24%**	**7%**	**100%**
Overall		**6%**	**32%**	**50%**	**9%**	**3%**	**100%**

Lamp stocking practices

Interviewers asked respondents whether their stores have a back stock of light bulbs in storage that are not displayed for sales. Table 10-49 shows the number of stores that have a back stock of light bulbs in storage.

Table 10-49. Number of stores that have back stock of light bulbs by PA and channel, 2019

PA	Channel	Have back stock	Don't have back stock	Don't know	Total
SCE	CHAIN DISCOUNT	1	12	0	13
	CHAIN GROCERY	0	4	0	4
	IND DISCOUNT	3	0	0	3
	IND GROCERY	0	1	2	3
	SCE Total	**4**	**17**	**2**	**23**
SDG&E	CHAIN DISCOUNT	1	13	0	14
	CHAIN GROCERY	2	2	0	4
	IND DISCOUNT	3	2	3	8
	IND GROCERY	7	2	3	12
	SDG&E Total	**13**	**19**	**6**	**38**
Overall	**Overall**	**17**	**36**	**8**	**61**

Table 10-50 shows the weighted percent of stores that have a back stock of light bulbs in storage.

Table 10-50. Percent of stores that have back stock of light bulbs by PA and channel, 2019

PA	Channel	Have back stock	Don't have back stock	Don't know	Total
SCE	CHAIN DISCOUNT	8%	92%	0%	100%
	CHAIN GROCERY	0%	100%	0%	100%
	IND DISCOUNT	100%	0%	0%	100%
	IND GROCERY	0%	33%	67%	100%
	SCE Total	**19%**	**62%**	**19%**	**100%**
SDG&E	CHAIN DISCOUNT	7%	93%	0%	100%
	CHAIN GROCERY	50%	50%	0%	100%
	IND DISCOUNT	38%	25%	38%	100%
	IND GROCERY	58%	17%	25%	100%
	SDG&E Total	**49%**	**29%**	**22%**	**100%**
Overall		**29%**	**51%**	**20%**	**100%**

Interviewers asked respondents what their stores do with any excess light bulbs that they cannot sell in a reasonable amount of time. Table 10-51 shows what stores do with excess light bulbs, in number of stores, by PA and channel.

Table 10-51. Process for excess light bulbs, in number of stores, by PA and channel, 2019

PA	Channel	Sells through bulbs	Bulbs remain on store floor	Keep excess bulbs in back	Send bulbs back to corporate warehouse	Send bulbs to different store	Don't know	Total
SCE	CHAIN DISCOUNT	9	1	1	0	1	0	12
	CHAIN GROCERY	4	0	0	0	0	0	4
	IND DISCOUNT	1	0	1	0	0	1	3
	IND GROCERY	0	0	0	0	0	2	2
	SCE Total	**14**	**1**	**2**	**0**	**1**	**3**	**21**
SDG&E	CHAIN DISCOUNT	5	6	1	2	0	0	14
	CHAIN GROCERY	1	1	1	0	0	1	4
	IND DISCOUNT	4	0	0	0	0	3	7
	IND GROCERY	1	1	8	0	0	2	12

PA	Channel	Sells through bulbs	Bulbs remain on store floor	Keep excess bulbs in back	Send bulbs back to corporate warehouse	Send bulbs to different store	Don't know	Total
	SDG&E Total	**11**	**8**	**10**	**2**	**0**	**6**	**37**
Overall		**25**	**9**	**12**	**2**	**1**	**9**	**58**

Table 10-52 shows what stores do with excess light bulbs, in weighted percent of stores, by PA and channel.

Table 10-52. Process for excess light bulbs, in percent of stores, by PA and channel, 2019

PA	Channel	Sells through bulbs	Bulbs remain on store floor	Keep excess bulbs in back	Send bulbs back to corporate warehouse	Send bulbs to different store	Don't know	Total
SCE	CHAIN DISCOUNT	75%	8%	8%	0%	8%	0%	100%
	CHAIN GROCERY	100%	0%	0%	0%	0%	0%	100%
	IND DISCOUNT	33%	0%	33%	0%	0%	33%	100%
	IND GROCERY	0%	0%	0%	0%	0%	100%	100%
	SCE Total	**54%**	**4%**	**10%**	**0%**	**4%**	**28%**	**100%**
SDG&E	CHAIN DISCOUNT	36%	43%	7%	14%	0%	0%	100%
	CHAIN GROCERY	25%	25%	25%	0%	0%	25%	100%
	IND DISCOUNT	57%	0%	0%	0%	0%	43%	100%
	IND GROCERY	8%	8%	67%	0%	0%	17%	100%
	SDG&E Total	**17%**	**13%**	**51%**	**2%**	**0%**	**17%**	**100%**
Overall		**40%**	**7%**	**25%**	**1%**	**3%**	**24%**	**100%**

Survey respondent positions

At the close of each survey, interviewers asked respondents for their position. Table 10-53 shows the number of respondents who were managers, cashiers/clerks, and stockers by PA and channel.

Table 10-53. Position of respondents, in number of stores, by PA and channel, 2019

PA	Channel	Cashier / Clerk	Manager	Stocker	Unknown	Total
SCE	CHAIN DISCOUNT	0	5	0	8	13
	CHAIN GROCERY	0	3	0	1	4
	IND DISCOUNT	0	2	0	1	3
	IND GROCERY	1	1	0	1	3

PA	Channel	Cashier / Clerk	Manager	Stocker	Unknown	Total
	SCE Total	**1**	**11**	**0**	**11**	**23**
SDG&E	CHAIN DISCOUNT	0	14	0	0	14
	CHAIN GROCERY	0	2	0	2	4
	IND DISCOUNT	3	1	0	6	10
	IND GROCERY	4	7	1	0	12
	SDG&E Total	**7**	**24**	**1**	**8**	**40**
Overall		**8**	**35**	**1**	**19**	**63**

Table 10-54 shows the weighted percent of respondents who were managers, cashiers/clerks, and stockers by PA and channel.

Table 10-54. Position of respondents, in percent of stores, by PA and channel, 2019

PA	Channel	Cashier / Clerk	Manager	Stocker	Unknown	Total
SCE	CHAIN DISCOUNT	0%	38%	0%	62%	100%
	CHAIN GROCERY	0%	75%	0%	25%	100%
	IND DISCOUNT	0%	67%	0%	33%	100%
	IND GROCERY	33%	33%	0%	33%	100%
	SCE Total	**9%**	**45%**	**0%**	**46%**	**100%**
SDG&E	CHAIN DISCOUNT	0%	100%	0%	0%	100%
	CHAIN GROCERY	0%	50%	0%	50%	100%
	IND DISCOUNT	30%	10%	0%	60%	100%
	IND GROCERY	33%	58%	8%	0%	100%
	SDG&E Total	**27%**	**58%**	**6%**	**9%**	**100%**
Overall		**15%**	**49%**	**2%**	**33%**	**100%**

10.10 Appendix J: Response to public comments

#	Section	Topic	Page	Comment	DNV GL Response
PG&E-1	Overarching	Overarching	NA	We commend DNV GL for providing a well-written draft final report that includes clear explanations of the methodology and the adjustments.	DNV GL appreciates the comment and the ensuing careful review of the report.
PG&E-2	Overarching	IESR tables	NA	Jeorge Tagnipes of the California Public Utilities Commission, Energy Division confirmed at the December 11, 2018 Quarterly Stakeholder meeting that all energy efficiency impact evaluations will contain IESR tables, i.e. tables in accordance with the CPUC Energy Division Impact Evaluation Standard Reporting Guidelines (November 2015, https://pda.energydataweb.com/api/view/1399/IESR_Guidelines_Memo_FINAL_11_30_2015.pdf). However, the draft report is missing the IESR tables. The IESR tables are critical for stakeholder review since they ensure: 1. Comprehensive evaluation results are documented, 2. Ex Ante vs. Ex Post savings are comparable, 3. Readers can easily access and identify important results, and 4. Results from different impact evaluations are comparable. Most of this information does not appear in the draft report. When will stakeholders be provided a complete draft, including IESR tables, for review before the final report is published?	The IESR tables were uploaded to the PDA on March 7. They are included in the appendices of this report.
PG&E-3	Overarching	Executive summary	1	The draft report does not include an Executive Summary, which is a critical part of the report. When will stakeholders be provided a complete draft for review, including executive summary, before the final report is published?	As noted in the draft report: "This report is being released pending Energy Division review to meet unusually short timelines as a result of contracting delays. This draft report does not include the Executive Summary. The Executive Summary will be compiled after comments from stakeholders on the main report have been received and have been assimilated to revise the report and inform final recommendations." The executive summary is included with this final version of the report.

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PG&E-4	4.1.2	Early retirement	23	The evaluation appears not to have taken into account the effects of early retirement (i.e., the share of installed LED lamps that replaced functioning lamps) on net savings estimates: On page 10 of the Impact Evaluation of 2015 Upstream and Residential Downstream Lighting Programs, DNV GL stated, "Consumer survey results suggest that 68% of LED lamps purchased by customers replaced functioning lamps. This finding suggests that there is a potential savings impact related to early replacement". DNV GL also provided the following recommendation: "The current evaluation results do suggest that this is something future evaluations should quantify these impacts, so we have added an explicit recommendation to do so." It appears this PY2017 impact evaluation did not quantify the impacts of early retirement. In the next impact evaluation, could DNV GL please investigate whether the program is leading to early retirement? Early retirement could have a significant impact on net savings, and so we believe it warrants incorporation into the analysis and greater discussion in the report and work plan.	Upstream lighting programs and evaluations have not typically incorporated the concept of early retirement into the program savings. A duel baseline for upstream programs would increase both the complexity and uncertainty with upstream lighting savings. The 2017 impact evaluation outlined the baseline approach in the research plan and early retirement was not included. We can revisit this with the 2018 impact evaluation research plan.
PG&E-5	8	Recommen-dations	71-73	The report recommendations are written as if they apply to all PAs: This evaluation found significantly different results by Program administrator (PA). The Recommendations section is addressed to all PAs, but many of these recommendations would address issues identified with SCE and SDG&E (but not PG&E) programs. For example, "Upstream lighting programs discounted too many lamps in the discount channels for stores to reasonably stock and sell. Program design needs to strike a balance between market size and program shipments". Could DNV GL please specify which PA(s) should follow each recommendation? Following these recommendations would require additional resources, so this additional clarification would be appreciated.	The recommendations specify which PAs had issues in the body text of the report. The summary graphics is meant to be brief and not too specific. We feel that the recommendations are applicable to all PAs moving forward.

#	Section	Topic	Page	Comment	DNV GL Response
PG&E-6	2.2	Baseline	4	We appreciate that DNV GL pursued a different approach to determining the baseline. We agree with DNV GL that the current ex ante assumptions for gross baselines and net-to-gross ratios that were developed in the 2017 disposition were not accurate. Could DNV GL please consider including a recommendation in the final report for the ex ante team to investigate how the baseline got so far off, to avoid future recurrences? The IOUs use ex ante values for important decision making including shifting funds and canceling measures, so it is important that these values be accurate.	The Group A contract includes closer integration between the impact evaluation and the ex ante team. The impact evaluation results will be used by the ex ante team to develop new baselines moving forward.
PG&E-7	4.1.2	Early retirement	23	Can DNV GL please discuss in the final report whether the lamp choice model and supplier or retailer surveys captured whether the consumers purchased lamps because of the program (where the counterfactual would be 0 bulbs)? If not, can these tools be adjusted so they do?	The Lamp Choice Model is an estimate of market shares for all lamp technologies and is therefore not designed to consider a lack of purchase as a discrete choice. We do ask in-depth interview respondents to estimate the quantity of program lamps (as a percentage of total program lamps) that sold because of the program. In the 2015 and 2017 evaluations, we used this value to establish a "channel shift" adjustment to the membership club channel. We will continue to explore this concept in the 2018 evaluation for the discount and grocery channels. We include the following update to the report in Section 3.8. "The Lamp Choice Model calculates the probability that a given customer would choose each lamp technology and shape, when program-discounted lamps were available. The model necessarily assumes that the customer will purchase a lamp. This assumption therefore does not capture the possibility that the program itself induced the purchase of the lamp. This assumption is predicated on the expectation that the upstream programs do not increase the overall volume of installed statewide lamps (there are only so many sockets in IOU territory to draw power and thus produce efficiency savings)."

#	Section	Topic	Page	Comment	DNV GL Response
PG&E-8	3	Data sources	13	Table 3-1 provides a helpful overview of how each data source was used. Can DNV GL please explain in the final report why the retail store manager surveys were not used for the free ridership estimates? We believe this was used as a data point for free ridership in past Upstream and Residential Downstream Lighting Impact Evaluations, and these indicated lower free ridership levels than consumer surveys.	In the 2015 and 2017 evaluations, DNV GL used survey responses with statewide representative weights to generate Lamp Choice Model simulations. The statistically representative rigor of the survey responses, and the discrete choice model methodology provide a more rigorous estimate of free-ridership than self-reported manufacturer and retail buyer responses. In addition, DNV GL designed and fielded the 2019 store manager survey with focused research questions to develop the sales-to-shipment ratio. Future store manager surveys may be expanded to address free ridership.
PG&E-9	3	Data sources	13, 53	The CREED data provides probably the best available information on residential lamp sales estimates by technology and could be used to inform the baseline. Did the evaluation team compare their results with the CREED data to check their results? For example, did DNV GL compare their "with program market share" estimates in Table 6-1 with CREED? If this was not feasible for methodological reasons, can DNV GL please explain why not?	The 2017 impact evaluation used the CREED sales data as a check to gauge the relative size of CA lighting market. We did not use the CREED sales data as input into any impact calculations. The CREED data do not provide a level of granularity that would allow for a comparison to the outputs from the lamp choice model.
PG&E-10	3	Data sources	15	The report states, "The secondary research objective of the surveys was to better understand what these stores do with any unsold PA-discounted lamps." We agree this is an important objective, but we didn't see the results presented in this report. Can the results be added to the final report? If not, can DNV GL please explain why not?	We have added survey disposition tables to the appendix (see Appendix I).

#	Section	Topic	Page	Comment	DNV GL Response
PG&E-11	3 and 5.4	Gross savings methodology	19, 37	The gross savings estimates use a baseline based on what is on shelves, not what is in people's sockets (which was the approach DNV GL used in the 2015 impact evaluation). So, the baseline identified in the 2017 evaluation reflects what people would have purchased in the absence of the program, not the bulbs replaced. Gross savings is supposed to represent savings at the meter, so this isn't following that precedent. Can DNV GL please discuss in the final report why they chose the approach they did for estimating gross savings, and any implications this may have as a result?	The 2017 baseline does reflect savings at the meter. The prior evaluation used an in situ baseline. The 2017 impact evaluation updated the baseline methodology to incorporate the best available data and to simplify the overall savings estimation to reduce uncertainty.
PG&E-12	4.1.5	Sales-to-shipment ratios	25	PG&E is not shown in table 4-5. Did the evaluators not make any sales-to-shipment adjustments for PG&E? If so, could DNV GL please add a sentence to that effect somewhere in this section?	We have added a footnote in Section 4.1.5 explaining why we did not conduct store manager surveys in PG&E's service territory and why we did not apply quantity adjustments to PG&E program lamps.
PG&E-13	4.4	Installation rate	32	Minor inconsistency: Table 4-13 show 90% installed and 8% in storage - will be installed (so 98% total). But paragraph above shows 99% were installed or will be installed in future. Should these numbers match up, or perhaps it's a rounding issue?	This was an error in the wording in the paragraph above. It has been corrected to 98% for the final report.
PG&E-14	5.4.2	Lamp shares without program	39	Figure 5-2 shows a significant number of incandescent A-lamps, which is a separate category from incandescent EISA A-lamps. Does the significant fraction of incandescent A-lamps indicate a significant level of non-compliance with the EISA standard, or are some of these bulbs exempt from EISA?	We haven't observed significant levels of EISA non-compliant incandescent A-lamps in recent shelf survey waves. However, we did see an increase in incandescent lamps that are exempt from EISA. Exempt incandescent lamps typically included rough or vibration service lamps (including ceiling fan lamps) or vintage style lamps.

#	Section	Topic	Page	Comment	DNV GL Response
PG&E-15	6.1.2	Net-to-gross ratio	52	The formula for NTGR seems like it would depend on the size of the Upstream Lighting program in that channel. If there is a low presence in that channel, it seems like it would lead to a low NTG. For example, this evaluation found a low NTG for the mass merchandise channel (34% for PG&E), which is surprising; is this because PG&E had a small presence in that channel? If so, is it appropriate for the NTG to depend on size of program? We thought it should reflect the likelihood of a customer purchasing an LED because of the rebate (which shouldn't depend on program size), but we may be thinking in the classic NTG methodology paradigm that uses basic consumer surveys to estimate NTG. Could DNV GL provide insights on this?	The formula for the NTGR is 1 - (MSwop/MSwp) where MSwop is Market Share without program discounts and MSwp is the market share with program discounts. It is important to emphasize that these market shares are only relative to purchases made in the presence of lamps with program discounts. In other words, every simulation that we run using with-program conditions necessarily includes a program discount. Each simulation's corresponding without-program condition simply removes the program discount from the program lamp price (as well as its availability if we have evidence that the lamp's stocking itself was dependent on the program). Therefore, the saturation of program activity does not impact this calculation. The commenter notes that the 34% NTGR is surprisingly low for the mass merchandise store. While price sensitivity may be high in this channel, lamp stocking and pricing practices in this channel are likely already designed to address those price sensitivities.

#	Section	Topic	Page	Comment	DNV GL Response
SCE-1	Overarching	Overarching	NA	SCE appreciates the programmatic recommendations in the report and has implemented process changes to address the impact evaluation results, particularly the sales to shipment anomalies. SCE will also work with the evaluation team to contact manufacturers and other supply chain partners to refine our new 2019 approach as well as understand the disposition of over shipped bulbs.	DNV GL appreciates the comment and the ensuing careful review of the report.
				As noted in the Response to Recommendations for the Impact Evaluation of the 2015 Upstream and Residential Downstream Page 1, "without program support, significantly fewer customers would have purchased energy efficient lamps in drug, grocery and hardware channels." With the recommendation to ship lighting to these channels in mind, SCE's focus has been to drive the lighting allocations towards smaller stores and away from big box retailers. As noted in the report, while the intention of the strategy was to increase participation through these channels, this should be balanced with managing stock across all channels.	DNV GL recognizes the effort to increase sales in channels where program activity can have the largest impact. We appreciate SCE's recognition that the appropriate balance was not struck in the 2017 program implementation.

#	Section	Topic	Page	Comment	DNV GL Response
				SCE has implemented and will continue to improve the program in response to the draft report including, but not limited to the following: a. Limit the shipments of bulbs to discount retailers and grocery stores and focus on the remaining delivery channels for its shipments. The focus will be on hardware, home improvement, and other "Big Box" retailers that have less challenges with greater volumes. We will work with all retailers that are able to provide sales data to more closely monitor stock levels and adjust future shipments as needed. b. Additional internal controls have also been added to prevent shipments to the same store from multiple manufacturers and increased the visibility to inspections. For those retailers that are currently overstocked, SCE is working with the manufacturers and retailers for a suitable solution that still generates a benefit for our ratepayers. c. SCE intends to incorporate ongoing and planned market studies authorized by the Commission's Research Roadmap into our lighting program efforts.	Acknowledged.

#	Section	Topic	Page	Comment	DNV GL Response
				SCE asks that the evaluation team consider a joint 2017 2018 evaluation to increase the precision of the estimates.	The 2018 impact evaluation will incorporate data collected in 2017. It is our understanding that the 2017 and 2018 evaluations will remain separate. A combined evaluation would need to be recommended and approved by the CPUC.
SCE-2	4.1.2	Data sources/market size	23	Section 4.1.2 of chapter 4 (page 23) provides data sources for the estimated market size of lighting in California. Since the upward bounds to SCE shipments are in part derived from these estimates of market size, SCE invites additional data sources to validate the CREE estimates, as one example. If this is not possible for 2017, SCE welcomes additional data sources for the 2018 evaluations. If distributor/manufacturer surveys are also used in future evaluations, we would welcome robust sample counts where possible to increase the precision of the estimates. a. The surveys could help identify the dispositions of over shipped bulbs. b. Additional data sources could provide additional references to the market size which provides an upper bound on sales.	For the 2017 impact evaluation, DNV GL used the best available data sources to try to triangulate market size. We recognize the difficulty in understanding market size, and we welcome additional sources to help understand the market. The CREED sales data was just one piece to try to understand the market. Because we understood the limitations of the data sources, we developed the store manager survey with the express purpose of developing a sales-to-shipment ratio for participating stores. When developing the scope of the 2018 evaluation, we will certainly consider additional data sources and methodologies to continue to increase the rigor of the sales-to-shipment ratio.
SCE-3	4.3	Leakage	31	Section 4.3 addresses leakage and notes that the 2018 impact study will address the disposition of unaccounted for bulbs. We appreciate that this will be addressed in the next evaluation and would also appreciate some insight into where 2017 bulbs are likely being used (if not in storage).	The 2018 impact evaluation will look at leakage more closely. We have added tables to the appendix to show store manager responses to questions about storage. More research will be needed to fully understand what happened to the 2017 bulbs.

#	Section	Topic	Page	Comment	DNV GL Response
SCE-4	8	Recommendations	71	Recommendation 4 on page 80 concludes that ex post baselines were higher than ex ante baselines. We appreciate the effort of DNV-GL to examine all inputs to delivering cost effective lighting programs, not only those under the control of the PAs. We look forward to additional research to verify other important lighting parameter baselines in other markets and applications.	Acknowledged.
SDG&E-1	4.1.3	Market size	24	The footnote to Table 4-3 states, "Consumer survey results show 3% of consumers buy their lightbulbs in the discount channel." However, the more recent study June 2018 "California Statewide Residential Lighting Customer Decision Study"1 Figure 6-12 (at page 37) show that 9% of purchased are at discount stores and 12% at groceries. If the result from the 2018 study is applied in the same manner as Table 4-3, the results would show that 10.8 million sales from discount stores and grocery stores would be 14.4 million sales, not 3-4 million shown in Table 4-3. Contrary to the Draft Study which states, "When comparing the estimated sales to the program shipments, it becomes clear that SCE and SDG&E discounted and shipped more lamps than these channels could support,"2 the estimated sales at these channels show that both SDG&E and SCE's shipments can be supported by the sales information. Therefore, there exists alternative information that can disprove the Draft Study's findings and therefore the Draft Study results should be appropriately discounted in calculating the final program results.	First, in the June 2018 "California Statewide Residential Lighting Customer Decision Study", Figure 6-12 (at page 37) shows where customers shop for light bulbs, not the volume of light bulbs they purchase. The percentages in the figure are not indicative of purchase volume, only where customers have shopped. Additionally because it is a multiple response question the percentages do not reflect market share but rather the diversity of where customers can purchase light bulbs. Second, we did not use the sales volume as a source for counting results, only as an indicator of market size to try to frame the issue. Even if we had applied the numbers stated in this comment, which are not applied to market size correctly, the program volume compared to market share would still raise red flags that required further research.(For example, grocery stores receiving 7.9 million program bulbs out of 10.8 million would suggest the program is 3/4 of the statewide discount market...) We agree that more research is needed to understand market size, but all the data sources we used to triangulate the market showed that program activity was vastly larger than market capacity in these channels.

#	Section	Topic	Page	Comment	DNV GL Response
SDG&E-2	4.3	Data sources/sales data	31	The Draft Study utilizes sales data from CREED only. However, market sales data is dependent on manufacturers/retailers' self-report, which may not always be accurate. SDG&E strongly recommends that additional sales data from other sources be used to triangulate or augment sales data from CREED. Examples of databases that can be used are CREED, A/C Nelson, NDP, etc. to optimize this activity. Each of these sales data bases has limitations so the triangulation may be the best approach to get better information on sales data.	The 2017 impact valuation used the CREED sales data as a check to gauge the relative size of CA lighting market. We did not use the CREED sales data as an input into any impact calculations. We agree that there are limitations in all sales data set and welcome suggestions for other data sources.
SDG&E-3	3.3	Data sources/quantity adjustments	15	We appreciate the extra survey DNV-GL conducted to investigate the apparent discrepancy for the discount stores. These surveys provide an alternative method to the CREED approach to determine sales. It is not clear how the survey data is used relative to the CREED data. Furthermore, this is a very compressed investigation with 20 out of 83 store managers not recalling selling program lamps. Table 3-2 represents that these 20 stores did not have any sales in the last 3 years. However, the Study does not provide the methodology used to extrapolate the results of these surveys and the weighting applied to these 20 survey results such that it can be extrapolated to the entire population. Without detailed information and estimation methodologies provided, this finding, as presented in the study, is not robust enough to make the adjustments to reduce the gross savings at this time.	The CREED data was not used in conjunction with the store manager survey. We have included the store manager survey instrument and results tables in the appendix of this report (see Appendix E and Appendix I). We have also posted an Excel file with anonymized survey results along with this report posting.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter, and greener.