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2014 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report

Prepared for
California Public Utilities Commission

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Executive Summary

This report documents the activities undertaken by the Nonresidential Downstream Custom Lighting Impact Evaluation of the 2014 investor-owned utilities' (IOU) energy efficiency programs. The overall goal of this study is to address the needs for ex post evaluation for custom measures as outlined in the Efficiency Savings and Performance Incentive (ESPI) decision.[1] As discussed in Appendix 2 of the decision, "for custom projects, all components of the projects will be subject to review. An evaluation based estimate of the savings claim for custom projects in the defined program year will be applied to the custom ex ante claim to adjust gross savings. Net to gross ratios will also be estimated for the projects based on ex post analysis."

For this evaluation, all nonresidential lighting measures that are considered to be custom (i.e., not deemed) were considered for this study. In 2014, energy savings from nonresidential downstream custom lighting measures represented 13% of the overall ex ante gross kWh savings portfolio for the Program Administrators' (PA) energy efficiency programs, and 9% of overall ex ante gross kW savings.

Based on the study goal, the primary research issues for this evaluation center around determining net and gross *ex post* impacts. These research objectives included the following:

- Confirm installations (verification). This included on-site verification of measure installation to confirm the installations reported by the PAs.
- Estimate baseline (both pre-retrofit and code/ISP based) and replacement (post-retrofit) equipment wattages, operating hours, and use shapes to support the estimate of energy savings values and 8,760 impact load shapes.
- Collect facility-wide and area square footage estimates (where applicable) in order to calculate baseline savings using the Lighting Power Density area method.
- Estimate participant free-ridership to support the development of net-to-gross ratios and net savings values.
- Estimate remaining useful life values for measures that are subject to a dual baseline, and update effective useful life estimates based on ex post operating hours.

[1] D.13.09.023, Decision Adopting Efficiency Savings and Performance Incentive Mechanism.

- Based on the above, estimate first year and lifetime gross and net ex post impacts (kWh, kW).
- Based on the ex post savings values, develop gross and net realization rates (GRRs and NRRs) that can be applied to the entire nonresidential downstream custom lighting population to estimate population level estimates of ex post gross and net savings, both first year and lifecycle.

1.1 Overview of Approach

Two distinct evaluation activities were performed, as summarized below.

Gross Energy Savings Analysis. The primary objective of this activity was to develop gross and net realization rates (ratio between *ex post* and *ex ante* savings) that can be applied to the participant population for the custom lighting measures, such that population estimates of gross savings can be estimated for both first year and lifecycle savings. For each sampled project in the analysis, ex post savings were evaluated by separately establishing a number of impact parameters including installation rates, annual operating hours and pre and post wattages. These parameters were estimated based on performing on-site audits on 58 projects and 4 desk reviews of application data and savings calculation workbooks.

Net-To-Gross Analysis. The objective of this analysis was to develop net-to-gross ratios (NTGR) for the custom lighting population. The approach for estimating NTGRs was based on a self-report methodology utilizing participant survey phone responses for 141 projects. This methodology was based on the large non-residential free ridership approach developed by the NTGR Working Group and documented in Appendix C of that report, *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Non-residential Customers*. The methodology estimated three separate measurements of free ridership from different inquiry routes and then averaged the values to derive the final free ridership estimate at the PA level.

1.2 Key Findings

Table 1-1 and Table 1-2 present the kWh and kW first year and lifecycle gross realization rates along with the corresponding ex ante and ex post gross kW and kWh savings for the overall nonresidential custom lighting population, by PA and statewide. The corresponding relative precisions are also shown.

Table 1-1: 2014 Population Level First Year Gross MWh and MW Savings, Realization Rates and Sample Relative Precisions by PA

PA	First Year Gross MWh Savings				First Year Gross MW Savings			
	Ex Ante Gross MWh Savings	Ex Post Gross MWh Savings	GRR kWh	Sample Relative Precision	Ex Ante Gross MW Savings	Ex Post Gross MW Savings	GRR kW	Sample Relative Precision
PG&E	126,615	100,369	79%	4%	16.0	13.0	81%	7%
SCE	133,278	100,332	75%	6%	15.1	11.6	77%	8%
SDG&E	12,423	12,394	100%	5%	2.1	2.3	112%	8%
Statewide	**272,316**	**213,094**	**78%**	**4%**	**33.2**	**27.0**	**81%**	**5%**

Table 1-2: 2014 Population Level Lifecycle Gross MWh and MW Savings, Realization Rates and Sample Relative Precisions by PA

PA	Lifecycle Gross MWh Savings				Lifecycle Gross MW Savings			
	Ex Ante Gross MWh Savings	Ex Post Gross MWh Savings	GRR kWh	Sample Relative Precision	Ex Ante Gross MW Savings	Ex Post Gross MW Savings	GRR kW	Sample Relative Precision
PG&E	1,384,575	1,002,849	72%	6%	178.0	122.3	69%	8%
SCE	1,387,300	1,185,469	85%	7%	165.3*	120.7*	73%	12%
SDG&E	148,038	121,914	82%	4%	25.3*	24.6*	97%	8%
Statewide	**2,919,913**	**2,310,232**	**79%**	**4%**	**368.7**	**267.6**	**73%**	**6%**

* Lifecycle kW savings for 7 claims (6 in SCE and 1 in SDG&E) were adjusted by the evaluation team. The 6 SCE claims reported 0 first year kW savings, but claimed lifecycle kW savings. The effect was marginal – ex ante gross MW went from 167.5 to 165.3 and ex post went from 122.6 to 120.7 MW. For the 1 SDG&E claim, first year kWh savings were multiplied by the EUL and this value was applied to the lifecycle kW savings. This effect was significant and the correction changed the ex ante gross MW from 1,742.65 to 25.3 and ex post from 1,299.55 to 24.6 MW.

The ex post operating hours and delta wattage for projects completed in PG&E were generally less than the ex ante claim which results in an overall first year kW and kWh GRR of 81% and 79%, respectively. For SCE, the resulting kW and kWh GRRs (77% and 75%) were driven most significantly by lower ex post operating hours. For SDG&E, the ex post operating hours were almost identical and delta wattages were very similar to the ex ante assumptions which lends itself to a kWh GRR of 100%. The ex post peak demand savings (especially for the large retail establishments) were also generally higher than ex ante estimates which helps to explain the kW GRR of 112%.

Despite these differences across PAs, the ex post kWh saving values produced GRRs with relative precision that ranged from 4% to 6% at the overall PA level at 90% confidence. At the statewide level, the kWh GRR had a relative precision of 4%.

Because many measures have a dual baseline, the gross realization rates associated with the first year savings will differ from the gross realization rates associated with lifecycle savings.

The ex post kWh saving values produced lifecycle GRRs with relative precision that ranged from 6% to 7% at the overall PA level at 90% confidence. At the statewide level, the lifecycle kWh GRR had a relative precision of 4%.

The gross realization rates presented above were based on the on-site sample, however NTGRs were developed for the larger participant phone survey sample. The phone survey was used as a recruitment tool for the on-site verification, so the on-site sample was embedded within the larger phone survey sample. For non-census segments, more phone surveys were completed than onsites to assure that the on-site quotas could be met. Table 6-5 presents the ex ante and ex post NTGR values weighted by ex post kWh and kW savings by PA and statewide, along with relative precisions.

Table 1-3: Comparison of Ex ante and Ex post NTGRs by PA with Relative Precisions, Weighted by kWh and kW Savings

Program Administrator	kWh Weighted Results			kW Weighted Results		
	Ex Ante NTGR	Ex Post NTGR	RP	Ex Ante NTGR	Ex Post NTGR	RP
PG&E	0.64	0.51	7%	0.65	0.52	6%
SCE	0.76	0.47	9%	0.73	0.46	8%
SDG&E	0.61	0.55	12%	0.61	0.61	10%
Statewide	**0.69**	**0.49**	**5%**	**0.68**	**0.51**	**4%**

At the PA level, ex post NTGs weighted by kWh range from 0.47 in SCE to 0.55 for SDG&E. While the ex post NTGs don't vary significantly across PAs, they do when compared to the ex ante values. For PG&E and SCE, the ex post kWh NTGs for the smaller projects (<50,000 kWh savings for PG&E and <75,000 kWh savings for SCE) were lower than any other sample segment for each PA at 0.44 and 0.37, respectively. This is compared to 0.71 for each PA at the very large segment level. For each of these PAs, indoor and outdoor LED fixture retrofit projects also represented a significant share of net project interviews completed (34 of 67 interviews for PG&E and 26 of 56 interviews for SCE). These types of projects, which included city street lights, billboards and parking lots, generally had kWh NTGs in the 0.44 to 0.49 range. For SCE, the ex ante NTG for all these projects was 0.85 which is significantly greater than what was collected as part of the ex post net interviews. For SDG&E, the very large segment had the highest kWh weighted NTG (0.69), which was based on a sample size of 2 and the large segment had the lowest at 0.43. This segment was represented by large corporate retail establishments and a federal military facility. Overall, at the statewide level, the ex post NTGRs are roughly 30% less than the ex ante values.

Table 1-4 and Table 1-5 present the kWh and kW first year net realization rates along with the corresponding ex ante and ex post first year net kW and kWh savings for the overall nonresidential custom lighting population, by PA and statewide. The sample sizes and corresponding relative precisions are also shown.

Table 1-4: 2014 Population Level First Year Net MWh and MW Savings, Realization Rates and Sample Relative Precisions by PA

	First Year Net MWh Savings				First Year Net MW Savings			
PA	**Ex Ante Net MWh Savings**	**Ex Post Net MWh Savings**	**NRR kWh**	**Sample Relative Precision**	**Ex Ante Net MW Savings**	**Ex Post Net MW Savings**	**NRR kW**	**Sample Relative Precision**
PG&E	80,182	50,715	63%	9%	10.2	6.8	66%	9%
SCE	102,381	47,144	46%	11%	11.2	5.3	47%	11%
SDG&E	7,619	6,807	89%	13%	1.3	1.4	112%	13%
Statewide	**190,181**	**104,666**	**55%**	**6%**	**22.7**	**13.5**	**59%**	**6%**

Table 1-5: 2014 Population Level Lifecycle Net MWh and MW Savings, Realization Rates and Sample Relative Precisions by PA

	Lifecycle Net MWh Savings				Lifecycle Net MW Savings			
PA	**Ex Ante Net MWh Savings**	**Ex Post Net MWh Savings**	**NRR kWh**	**Sample Relative Precision**	**Ex Ante Net MW Savings**	**Ex Post Net MW Savings**	**NRR kW**	**Sample Relative Precision**
PG&E	879,476	506,731	58%	9%	114.1	63.6	56%	10%
SCE	1,050,326	557,025	53%	11%	120.5*	55.1*	46%	14%
SDG&E	89,849	66,958	75%	13%	15.4*	15.1*	98%	13%
Statewide	**2,019,652**	**1,130,714**	**56%**	**7%**	**250.0**	**133.9**	**54%**	**8%**

* Lifecycle kW savings for 7 claims (6 for SCE and 1 for SDG&E) were adjusted by the evaluation team. The 6 SCE claims reported 0 first year kW savings, but claimed lifecycle kW savings. The effect was marginal – ex ante net MW went from 121.8 to 120.5 and ex post went from 56.0 to 55.1 MW. For the 1 SDG&E claim, first year kWh savings were multiplied by the EUL and this value was applied to the lifecycle kW savings. This effect was significant and the correction changed the ex ante net MW from 1,045.8 to 15.4 and ex post from 798.0 to 15.1 MW.

The NRRs differ from the GRRs due to differences between the ex post and ex ante NTGRs. For PG&E and SCE, the ex post NTGRs are less than the ex ante NTGRs, which explains why the NRRs are lower than the GRRs. The SDG&E first year kW NRR is almost identical to the first-year GRR because the ex post NTG was almost identical to the ex ante NTG.

Overall, the ex post gross savings and NTG produced first-year NRRs with relative precision that ranged from 9% to 13% at the overall PA level at 90% confidence. At the statewide level, the NRR had a relative precision of 6%.

The objective of this study was to develop lifecycle NRRs that could be used to estimate IOU level savings across all nonresidential custom lighting measures that are statistically significant. The ex post kWh saving values produced lifecycle kWh NRRs with relative precision that ranged from 9% to 13% at the overall PA level at 90% confidence and kW NRRs at the 10% to 14% range. At the statewide level, the lifecycle kWh NRR had a relative precision of 7%, compared to the target of 90/20 and the lifecycle kW NRR had a relative precision of 8%.

1.3 Key Recommendations

This section presents recommendations related to the findings developed for this evaluation. Section 7 of the report explains each of these recommendations in more detail. The recommendations are directed at parameters that comprise the energy savings calculations.

- Projects that claim a program-induced early retirement must provide sufficient documentation to justify early replacement (ER).
- Program tracking data that correspond to early replacement projects using a dual baseline should ensure that the reported RUL does not equal the reported EUL.
- Further research should be done to consider a framework for NTGRs that can be applied to measures that have a dual baseline, where separate NTGRs are developed for the RUL and post-RUL periods to incorporate the program's influence on both the timing and efficiency of the installed equipment.

2

Introduction

This report documents the activities undertaken by the Nonresidential Downstream Custom Lighting Impact Evaluation of the 2014 investor-owned utilities' (IOU) energy efficiency programs. The overall goal of this study is to address the needs for ex post evaluation for custom measures as outlined in the Efficiency Savings and Performance Incentive (ESPI) decision.[2]

This report presents the findings and results from this evaluation, which includes a presentation of the goals and objectives of the evaluation, the researchable issues, data sources used, the approach for sampling, the methods to determine gross and net impacts, and the resulting ex post net and gross energy and demand impacts.

2.1 Goals and Objectives

As mentioned, the overall goal of this evaluation is to address the needs for ex post evaluation for custom measures as outlined in the ESPI decision. As discussed in Appendix 2 of the decision, "for custom projects, all components of the projects will be subject to review. An evaluation based estimate of the savings claim for custom projects in the defined program year will be applied to the custom ex ante claim to adjust gross savings. Net to gross ratios will also be estimated for the projects based on ex post analysis."

2.2 Overview of Measures to be Studied

This study is a component of the larger Nonresidential Downstream Impact Evaluation Work Order. The objectives for this study are very focused in meeting the needs for ex post evaluation for custom measures as outlined in the ESPI decision. For this evaluation, all nonresidential lighting measures that are considered to be custom (i.e., not deemed) were considered for this study. Specific measures were not targeted, however. Instead, a stratified random sampling of projects was selected that covered a variety of nonresidential downstream lighting measures.

In 2014, energy savings from nonresidential downstream custom lighting measures represented 13% of the overall ex ante gross kWh savings portfolio for the Program Administrators' (PA) energy efficiency programs, and 9% of overall ex ante gross kW savings. Table 2-1 summarizes

[2] D.13.09.023, Decision Adopting Efficiency Savings and Performance Incentive Mechanism.

the total savings claim by PA and statewide for 2014. Shown are the absolute savings, and the savings expressed as a percentage of each PA's total portfolio savings (as well as the statewide totals, and percentage of the statewide savings).[3]

Table 2-1: Summary of 2014 Nonresidential Downstream Lighting Gross Ex Ante Savings

	Total Savings		Savings as a % of Portfolio	
IOU/PA	**GWh**	**MW**	**kWh**	**kW**
PG&E	126.6	16.0	15%	10%
SCE	133.3	15.1	13%	9%
SDG&E	12.4	2.1	7%	6%
Statewide	**272.3**	**33.2**	**13%**	**9%**

2.3 Evaluation Approach and Research Objectives

Based on the study goal, the primary research issues for this evaluation center around determining net and gross *ex post* impacts. For this evaluation, a GRR approach was employed, where site-specific gross ex post impacts were estimated for a sample of participants. These site-specific gross ex post impacts were then compared to the ex ante impact from the tracking data to develop a ratio of ex post to ex ante gross savings, which is the GRR, or the percentage of ex ante savings realized in the ex post evaluation. As will be discussed in more detail in this report, a set of GRRs were developed by PA, which were then applied to the entire population of participants to create a population estimate of ex post gross savings. This approach is consistent with that employed for the 2013 Custom Lighting ESPI evaluation,[4] as well as the custom measures under the 2010-12 Nonresidential Downstream Lighting Impact Evaluation.[5]

A separate NTG analysis was then performed using a self-report analysis based on participant phone survey data. This analysis resulted in a set of NTGRs by PA that were then applied to the population's gross savings values in order to estimate net savings.

3 It is important to note that all savings expressed in terms of a percentage of the portfolio do not include savings from Codes and Standards, as these savings were not reported in the PA tracking data.

4 http://www.energydataweb.com/cpuc/deliverableView.aspx?did=1294&uid=0&tid=0&cid=

5 http://www.energydataweb.com/cpuc/deliverableView.aspx?did=1155&uid=0&tid=0&cid=

In order to implement this approach in meeting the overall study goal, a number of research objectives were required, as follows.

- Confirm installations (verification). This included on-site verification of measure installation to confirm the installations reported by the PAs.
- Estimate baseline (both pre-retrofit and code/ISP based) and replacement (post-retrofit) equipment wattages, operating hours, and use shapes to support the estimate of energy savings values and 8,760 impact load shapes.
- Collect facility-wide and area square footage estimates (where applicable) in order to calculate baseline savings using the Lighting Power Density area method.
- Estimate participant free-ridership to support the development of NTGRs and net savings values.
- Estimate remaining useful life values for selected measures, and update effective useful life estimates based on ex post operating hours.
- Based on the above, estimate first year and lifetime gross and net ex post impacts (kWh, kW).
- Based on the ex post savings values, develop gross and net realization rates (GRRs and NRRs) that can be applied to the entire nonresidential downstream custom lighting population to estimate population level estimates of ex post gross and net savings, both first year and lifecycle.

The remainder of this report will discuss the following:

- Section 3 discusses the data sources that were utilized to estimate each of the individual parameters that comprise the impact load shapes.
- Section 4 discusses the sample design and resulting data used in the evaluation.
- Section 5 provides a high level discussion of the overall impact evaluation approach for estimating net and gross savings and compares the site-project specific ex ante and ex post impact parameters that make up the GRRs.
- Section 6 presents the final study results, including the GRRs and NRRs and total population level ex post energy savings values.
- Section 7 presents the study’s conclusions and recommendations.
- Appendix A presents the participant telephone survey instrument.
- Appendix B presents the on-site survey instrument.
- Appendix C presents a detailed description of the methods used for estimating each individual impact parameter, including the measure quantities, the various wattage values, the pre and post operating hours, and the RUL.

- Appendix D presents the phone survey banners.
- Appendix AA presents the standardized high level savings for both gross and net first year and lifecycle.
- Appendix AC presents the summary of recommendations for the Response to Recommendations (RTR).

3

Data Sources

This section outlines key primary and secondary sources of information utilized in this evaluation. Section 4, Evaluation Methodology, also discusses how the approaches and methodologies utilized these data sources.

3.1 Key Data Sources

3.1.1 Program Tracking Data and Participant Applications

Program tracking data were provided and uploaded by each of the PAs onto a centralized server. These separate data sets were analyzed, cleaned, re-categorized, reformatted, and merged into one program tracking database. From these data the sample was drawn. Participant applications were requested for all sites that were evaluated, and key information from the applications were entered into the evaluation database.

Customer account managers were contacted for many projects as well after the participant applications had been received and processed. This effort help facilitate the recruitment of projects for both the on-site audits as well as the participant phone survey.

3.1.2 On-Site Audits

On-site visits collected data to support a number of parameters used in the impact algorithm. Verification data were collected to support installation rates. Equipment manufacturer and model numbers were collected in order to perform lookups that provide information on the wattage of installed and replaced equipment to support the estimate of pre- and post-retrofit wattages. Furthermore, for some onsites, spot watt measurements were taken to estimate post-installation wattage. Self-report data was also gathered on the wattage of pre-existing equipment when actual equipment replaced was not on site and project applications did not document pre-wattages, to help support the estimate of pre-retrofit wattages. Facility-wide and area square footage estimates were also collected for projects that were deemed “New Construction” or utilized a Lighting Power Density area method for the second baseline. Finally, self-report data was gathered on lighting equipment usage schedules to aid in the development of pre- and post-retrofit load shapes.

3.1.3 Time of Use Lighting Loggers

As part of the on-site audit, installed lighting equipment was also monitored to gather time-of-use to support the development of operating hours. Lighting loggers that employ optical sensors were the predominant type of monitoring equipment used for this study. However, when lighting was not accessible for optical sensors, logging was done at the electrical panel by collecting circuit amperage.

3.1.4 Participant Phone Survey

A phone survey was conducted to recruit customers for the on-site visit, as well as collect data useful for the NTG analysis and various other components of the evaluation. One other key use of the phone survey data was to identify if customer installations were early replacement (ER) or replacement on burnout (ROB), or verify the ER claim provided in the customer's application documentation.

3.1.5 Commercial Market Share Tracking Study Data

The Commercial Market Share Tracking study provided information on lighting equipment installations that occurred outside of the CPUC programs. This information was utilized to develop industry standard practices for lighting retrofits.

4

Sample Design and Data Collection

There were two primary data collection activities, which were on-site and participant phone surveys. Both sample designs are discussed below.

4.1 On-Site Sample Design and Data Collection

As mentioned above, the on-site visits collected data to support a number of the impact parameters including the installation rates, pre and post wattages and pre and post operating hours. The overall objective of the sample design was to develop net first-year and lifecycle realization rates at a reasonable level of relative precision, while considering the budget allocated for this activity. This objective is based on the fact that the ESPI incentive mechanism is based on net lifecycle savings. Separate realization rates were developed by PA. Because PG&E and SCE have significantly larger savings claims, more resources were dedicated to evaluating net lifecycle savings for those PAs.

To improve the statistical precision of the PA-specific realization rates, the sample was further stratified by project size (very large, large, medium and small), with a large percentage of the projects being evaluated on the very largest projects. Therefore, the sample was stratified into 12 segments (3 PAs x 4 Size Strata) in order to develop population level estimates of net lifecycle for each of the three PAs. The precision objectives were set at measuring the net lifecycle savings at a relative precision of approximately 30% for PG&E and SCE at the 90% confidence level (90/30), and 90/40 for SDG&E due to its smaller population size.

To meet these levels of targeted precision, a sample size of 60 projects was chosen (22 for PG&E, 22 for SCE and 16 for SDG&E). These sample sizes were based on estimates of coefficients of variation (COV) developed from the 2013 Custom Lighting ESPI evaluation. For the large and medium sized projects, a COV of approximately 0.85 was found, and a slightly higher COV of 1.0 was found for the smaller projects.

Table 4-1 presents the sample design along with the actual number of projects that were sampled for the on-site audit. Statewide totals are also presented which represent the total number of site-projects that were completed in 2014 along with the sampled ex ante savings that were evaluated. A total of 62 site-projects were sampled from the population which correspond to roughly 12.5%

of the total ex ante savings claimed for the population (and over 28% of the combined large and very large segment's savings).

Table 4-1: Sample Design and Achieved Data Collection for On-Site Sample

PA	Project Size	Project Size (MWh)	Population # of Projects	2014 Ex Ante kWh Savings	Percent Savings w/in PA	Target Sample Size	Achieved Projects Sampled	Achieved Ex Ante Savings Sampled
PG&E	Very Large	>1,600	4	14,344,989	11%	4	4	14,344,989
	Large	250 to 1,600	74	34,485,981	27%	6	6	3,166,338
	Medium	50 to 250	334	41,037,956	32%	6	7	604,107
	Small	<50	2,423	36,746,076	29%	6	6	39,096
PG&E Total			**2,835**	**126,615,003**	**100%**	**22**	**23**	**18,154,530**
SCE	Very Large	>1,600	4	8,723,642	7%	4	3	6,128,503
	Large	300 to 1,600	76	45,672,349	34%	6	6	4,317,778
	Medium	75 to 300	265	48,325,044	36%	6	8	1,255,821
	Small	<75	1,593	30,556,525	23%	6	6	262,874
SCE Total			**1,938**	**133,277,560**	**100%**	**22**	**23**	**11,964,976**
SDG&E	Very Large	>420	4	2,336,001	19%	4	3	1,751,257
	Large	225 to 420	13	4,355,083	35%	4	4	1,368,080
	Medium	75 to 225	21	3,291,489	26%	4	4	776,157
	Small	<75	110	2,440,500	20%	4	5	88,649
SDG&E Total			**148**	**12,423,073**	**100%**	**16**	**16**	**3,984,143**
Statewide	Very Large		12	25,404,633		12	10	22,224,749
	Large		163	84,513,413		16	16	8,852,196
	Medium		620	92,654,489		16	19	2,636,085
	Small		4,126	69,743,102		16	17	390,619
Statewide Total			**4,921**	**272,315,636**		**60**	**62**	**34,103,649**

The overall sample target for each PA was reached, however, the evaluation team was unable to complete 2 projects at the size strata level (1 very large project in both SCE and SDG&E). SCE and PG&E's populations both exceeded well over 1,500 projects, whereas the participant population for SDG&E was only 148, which created some limitations. Of those 148 projects in SDG&E, however, many represented only one site contact, so the total unique participants was even lower than the 148 total. In an attempt to increase the recruitment rate, the evaluation team requested the applications for all the SDG&E projects completed in 2014. Along with the application request, the evaluation team also requested account representative information for every project (when available) in order to facilitate a higher recruitment rate. Many of these projects involved corporate contacts with offices outside of California so it was imperative to enlist the cooperation of the account representatives.

Table 4-2 provides a summary of the facility types that were sampled as part of the 2014 impact evaluation along with the number of on-site completes and the percentage of first year ex ante sample savings associated with each facility type (by PA). While the sample design was not facility specific, these data provide additional information regarding the types of custom projects that were sampled in 2014.

Table 4-2: On-Site Sample Distribution by PA and Facility Type

PA	Facility Type	Achieved On-Site Sample	Percentage of Sampled Ex ante Savings
PG&E	City Street Lighting	1	2.7%
PG&E	Grocery	2	14.5%
PG&E	Manufacturing/Light Industrial	3	46.7%
PG&E	Other	11	4.3%
PG&E	Warehouse	6	31.8%
SCE	Education - University	1	1.8%
SCE	Manufacturing/Light Industrial	3	30.8%
SCE	Military	1	9.8%
SCE	Other	10	6.3%
SCE	Retail - Large	5	17.3%
SCE	Warehouse	3	34.1%
SDG&E	Manufacturing/Light Industrial	1	15.8%
SDG&E	Military	1	1.6%
SDG&E	Office - Large	1	7.1%
SDG&E	Other	6	1.9%
SDG&E	Retail - Large	7	73.6%

In PG&E, roughly 47% of the ex ante sample savings were associated with manufacturing/light industrial projects. This facility type was represented in three of the PG&E strata including the very large category where a census was completed. Warehouse and grocery also constituted a significant percentage of sampled savings at 31.8% and 14.5%, respectively. A large city street light project was also represented. In SCE, the sampled ex ante savings by facility type were more evenly distributed between warehouses (34.1%), manufacturing/light industrial (30.8%), large retail (17.3%) and a large military facility (9.8%). Both warehouses and manufacturing/light industrial facilities were represented in three strata including the very large segment. In SDG&E, the most significant sampled savings were found in large retail (73.6%)

followed by manufacturing/light industrial. The seven large retail facilities were included in three of the sample strata including 3 in both the medium and large strata as well as one in the very large category.

As will be discussed throughout the remainder of the report, the ex ante claim and ex post impact for each of these projects incorporate several variables, including installation rates, operating hours, coincidence factors, installed/replaced wattages and industry standard wattages. Likewise, many measures have a dual baseline, which affect the lifecycle savings associated with it.

The differences in GRRs across program administrators are predicated on differences among these variables. The magnitude of influence for many of these parameters is also predicated on the types of facilities where the measures have been installed. Likewise, the potential variance within a specific parameter when comparing the ex ante claim to the ex post can be significant. For example, when a municipality retrofits their city street lights that operate on a specific night time schedule, the ex post operating hours may be very similar to the ex ante claim. The same is potentially true of large retail establishments that operate on EMS systems. The opposite may be true of facilities that claim an overall building specific operating hour schedule, but the evaluation team discovered a greater distribution of measure installation in lower usage areas like restrooms and storage areas.

4.2 Participant Phone Survey Sample Design and Data Collection

One of the key objectives of the phone survey was to develop NTGRs for each PA. This analysis was done based solely on the participant phone survey responses. The NTGR survey battery was administered as part of the recruitment for the onsite audits. Therefore, the same stratification scheme was used for sampling the telephone surveys (PA and project size). The precision objective for the phone surveys was to estimate the NTGRs at a relative precision of approximately 10% for each PA at the 90% confidence level. This is based on a COV estimate of 0.3 obtained from the 2013 Custom Lighting ESPI evaluation and the 2010-12 Nonresidential Downstream Lighting Impact Evaluation.

As discussed above, the evaluation team requested assistance from the PAs and their account representatives to recruit customers for the phone survey and onsites. However, for the smaller sites that do not have an account representative, recruitment was done solely through the phone survey. For these smaller customers the evaluation team expected to get a recruitment rate around 50%. Therefore, we expected to have more participants contacted for surveys than for on-site audits in the <50,000 kWh project size stratum.

Separate NTGRs were estimated for each PA based on the results of the phone survey. Not all participants in the onsite sample, however, were recruited from the phone survey. The evaluation team was unable to conduct a phone interview with one of the participants that represented two distinct very large projects (one in SDG&E and another in SCE). The evaluation team was able to recruit the projects for the on-site verification component of the impact evaluation with the assistance of the account representatives and another corporate contact (an individual who was not responsible for the decision-making process associated with the implementation of the projects). Therefore, for one unique participant, the on-site visits that were conducted for the two projects were included in the gross analysis, but given the fact that the NTGR survey battery was not conducted, they were not part of the NTG analysis. Conversely, some participants agreed to the phone survey, but refused the on-site visit, so those participants were used in the NTGR analysis, but not the gross analysis.

Table 4-3 presents the sample design along with the actual number of projects that were sampled by PA. Also shown are the number of on-site completes, the number of phone survey completes without a corresponding on-site complete and the total projects achieved. Also shown are the number of NTGR surveys completed that corresponded to participants that also had an onsite conducted versus those that did not. A total of 143 site-projects were sampled from the 2014 nonresidential custom lighting population. As discussed above, the sum of the total on-site and phone survey only sample (143) is greater than the total achieved (141) because a NTG interview was not conducted for one unique program participant that represented two projects (1 in SCE and 1 in SDGE).

Table 4-3: Sample Design and Achieved Data Collection for Phone Sample

Program Administrator	Target Sample Size	Achieved from On-Site Sample	Achieved from Survey Only (No On-Site)	Total Achieved Projects Sampled
PG&E	28	23	44	67
SCE	28	23	34	56
SDG&E	20	16	3	18
Statewide	**76**	**62**	**81**	**141**

5

Evaluation Methodology

This section provides an overview of the methods that were used to estimate the gross and net savings values and corresponding realization rates. Appendix C provides a detailed description of the approach used to estimate each individual parameter in the gross savings algorithm.

5.1 Overview of Gross Impact Evaluation Approach

For this evaluation a GRR approach was utilized, where site-specific gross ex post impacts were estimated for a sample of participants. These site-specific gross ex post impacts were then compared to the ex ante savings claims from the tracking data to develop a ratio of ex post to ex ante gross savings, which is the GRR, or the percentage of ex ante savings realized in the ex post evaluation. A set of GRRs was developed by PA, which was then applied to the entire population of participants to create a population estimate of ex post gross savings.

The general approach that was used to estimate site-specific ex post gross savings values is based on developing hourly impacts to create an impact load profile. From this profile, impacts were then aggregated to develop an annual ex post gross kWh savings value, or averaged over a set of specific hours to develop an ex post gross kW savings value. The general algorithm applied to estimate energy savings for a specific hour is:

$$\text{Impact\_Hour\_i} = \text{Measure\_Qty} \times \begin{bmatrix} (\text{Baseline\_Wattage} \times \text{Percent\_On\_Pre\_Hour\_i}) \\ -(\text{Post\_Wattage} \times \text{Percent\_On\_Post\_Hour\_i}) \end{bmatrix}$$

Where,

Measure_Qty = the quantity of measures found to have been installed and operable based on an on-site visit.

Baseline_Wattage = the wattage associated with the measures that were replaced or with measures corresponding to the industry standard practice (or code) for the type of retrofit. As discussed in detail below, some measures employed a dual baseline over the life of the measure, while others were based solely on industry standard practice or code (or solely on the replaced wattage).

Post_Wattage = the wattage associated with the measures that were installed.

Percent_On_Pre = the percentage of time the baseline equipment was on during a specific hour i, which was obtained from adjusted self-reported operating hours gathered on site or monitored HOUs if applicable.

Percent_On_Post = the percentage of time the installed equipment was on during a specific hour i, which was obtained from adjusted self-reported operating hours gathered on site. The Percent_On_Pre and Percent_On_Post were assumed to be equal for all measures, except occupancy sensors.

One final parameter that was utilized to estimate annual energy and demand impacts was the HVAC interactive effects. The Database for Energy Efficient Resources (DEER) provides a set of factors that were used to incorporate the kWh and kW HVAC interactive effects associated with the installed measures. The kWh factors were multiplied by the annual kWh impact for a given participant, and the kW factors were multiplied by the kW demand impact. Different factors were applied to a given measure and participant based on if the measure is a CFL or not, the participant's PA, the climate zone where the participant is located, the participant's HVAC system type, the building type of the participant, and if the participant's facility is new or existing.

For many measures evaluated under this study, impacts were estimated differently for customers that replaced their equipment on burnout, as a result of a natural replacement or were new construction, as opposed to those that were influenced by the program to make an early replacement. Typically, for customers that performed a replacement on burnout (ROB), were natural replacement (NR), or were new construction (NC), the baseline equipment for estimating impacts for the effective useful life (EUL) of the project is considered to be industry standard practice, or code if the project is new construction or triggers Title 24.

When a measure was considered an early replacement (ER), the lifecycle savings were examined over two distinct time periods. The first time period was associated with the replaced equipment's remaining useful life (RUL), which was the period over which the accelerated program adoption was considered to have been made. During the RUL time period, the baseline equipment for estimating impacts was the equipment that was replaced. However, for the post-RUL period through the measures' EUL, the baseline equipment for estimating impacts was typically considered to be industry standard practice or code, because at the end of the RUL the customer would have had to replace their equipment with efficiency level not less than code or industry standard practice. This methodology is also referred to as the dual baseline approach, as there are two different baselines that are applied to projects considered to be ER.

The specific application of the dual baseline was determined on a measure by measure basis, as was the use of industry standard baselines for the ROB case and the post-RUL period. The dual baseline approach was applied to linear fluorescent, LED fixture, Induction and HID measures, but not for CFLs, LED lamps and occupancy sensors. Because CFLs and LEDs typically replace incandescent lamps, or lamps which have a very small EUL, it was assumed that they are always ROB. Occupancy sensors installed under the program are typically installed as part of a lighting retrofit. When estimating savings for a lighting retrofit along with occupancy sensors, the impact associated with the occupancy sensors was considered to be the incremental measure whose savings was based on the installed equipment. Therefore, the wattage affected by the occupancy sensor was the post-retrofit wattage for the occupancy sensor's full EUL and no dual baseline would apply.

Appendix C discusses the methods used to estimate each individual impact parameter, including the installation rate, the various wattage values, the pre and post operating hours and the EUL/RUL.

5.2 Overview of Net-to-Gross Analysis

For the 2014 program, the approach for estimating NTGRs was based on the same approach utilized for the 2013 Custom Lighting ESPI evaluation, as well as the 2010-12 Nonresidential Downstream Lighting Impact Evaluation, which relied solely on participant phone survey data. The NTGR methodology utilized for these evaluations was based on the large non-residential free ridership approach developed by the NTGR Working Group and documented in Appendix C of that report, *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Non-residential Customers*. The NTGR is calculated as the average of three program attribution indices (PAI) known as PAI-1, PAI-2, and PAI-3. Each of these scores represents the highest response or the average of several responses given to one or more questions about the decision to install a program measure. The participant phone survey was the basis for the inputs to each score.

- **Program attribution index 1 (PAI–1)** is a score that reflects the influence of the most important of various program-related elements in the customer's decision to select a given program measure. The PAI-1 score is calculated as the highest program influence factor divided by the sum of the highest program influence factor and the highest non-program influence factor. Some example non-program factors are: previous experience with the measure, recommendation from an engineer, standard practice, corporate policy, compliance with rules or regulations, organizational maintenance or equipment replacement policies and "other – specify." Payback is treated as a program influence factor if the rebate/incentives played a major role in meeting payback criteria, but is treated as a non-program influence factor if it did not play a major role in meeting payback criteria.

- **Program attribution index 2 (PAI–2)** is a score that captures the perceived importance of program factors (including rebate/incentives, recommendation, and training) relative to non-program factors in the decision to implement the specific measure that was eventually adopted or installed. This score is determined by asking respondents to assign importance values to the program and most important non-program influences so that the two total 10. The program influence score is adjusted (i.e., divided by 2) if respondents had made the decision to install the measure before learning about the program. The final score is divided by 10 to be put into decimal form, thus making it consistent with PAI-1.
- **Program attribution index 3 (PAI–3)** is a score that captures the likelihood of various actions the customer might have taken at the given time and in the future if the program had not been available (the counterfactual). This score is calculated as 10 minus the likelihood that the respondent would have installed the same measure in the absence of the program. The final score is divided by 10 to put into decimal form, thus making it consistent with PAI-1 and PAI-2.

The NTGR was estimated as an average of these three scores. If one of the scores was not available (generally due to respondents giving a "don't know" or "refusal" response), then the NTGR was estimated as the average of the two available score. If two or more scores were missing, results were discarded from the calculation.

5.3 Ex Ante and Ex Post Parameter Comparison

The objective of this study was to develop GRRs that could be used to estimate IOU-level savings across all nonresidential custom lighting measures that are statistically significant. As mentioned in Section 4.1 and detailed in Appendix C, the GRR incorporates several variables, including installation rates, operating hours, coincidence factors, installed/replaced wattages, industry standard wattages and EULs. Likewise, many measures have a dual baseline, which affect the lifecycle savings associated with it. The differences in GRRs within as well as across each program administrator are predicated on differences among these variables. The following section presents a high level comparison of the ex ante assumptions associated with the projects that were evaluated to the ex post impacts that were calculated as a result of the on-site audits.

The ex ante assumptions combine data collected from reviewing the application project documentation and calculation workbooks along with information garnered from the program tracking data. The ex post impacts were developed using a combination of data collected onsite along with data collected from the project documentation and the phone survey. Operating hours and coincidence factors were estimated using a combination of logger data and adjusted self-report operating schedules. The post-retrofit wattage of the incented equipment was calculated using a combination of make-model lookups and visual verification of installed equipment. Another function of the make model lookups was to determine manufacturer rated lamp life for select measures to update the EUL of each measure (combined with the ex post operating hours). This exercise was most specifically tailored toward LED lamp and LED fixture measures. The baseline wattage estimates were drawn from a combination of visual verification during the on-site audit and the project documentation. In the event that an on-site auditor could not determine the type and wattage of the baseline equipment from actual baseline equipment found onsite, the baseline wattage that was collected from the project documentation was used. If a measure was classified as ER within the project documentation, the evaluation team attempted to substantiate the claim using information collected from the project documentation data request. In the event that an ER/ROB designation was not detailed in the project documentation, the project was classified as ER or ROB based on the phone survey only. Some ER claims were changed to ROB as well. If an LED lamp measure replacing an incandescent or a halogen was classified as an ER measure in the project documentation, the evaluation team reversed that classification because the RUL of the incandescent or halogen would be approximately a year or less, not justifying an ER designation.

It's important to note that while the evaluation team was successful in comparing the ex ante assumptions from the application documentation to the ex post impacts for every project, not all measures within each project were successfully compared. While infrequent, it was sometimes difficult to calculate the ex ante impact of a measure given missing or incomplete information furnished in the project documentation.

For some projects, the quantity of baseline equipment for a given measure was greater than the retrofit quantity so the following summaries compare the total baseline wattage to the total retrofit wattage for each measure. It was difficult to confirm whether or not the baseline quantity furnished in the project documentation was correct from the on-site verification so, in these cases, the pre-retrofit quantities collected from the application were multiplied by the baseline wattages collected from the ex post audit. This approach also allows for a consistent comparison to new construction projects that utilized an LPD approach. Since these projects utilize an allowable LPD based on square footage and facility type and have no baseline quantities, the total allowable baseline wattage is used in the pre-case.

Table 5-1 provides comparative summaries of these impact parameters at the sample strata level as well as at the PA level. As mentioned, this requires examining multiple parameters and comparing ex ante and ex post results to understand the differences in each parameter and how they influence the overall GRR. These summaries are intended to be instructive and are not presented to completely explain the differences in ex ante and ex post values. Rather, they are presented to provide a more general understanding of what specific parameters are driving the GRR.

Table 5-1: Comparison between Ex Ante and Ex Post Impact Parameters

PA	n	Ex Post Hours	Ex Ante Hours	Post Hour Ratio	Ex Post Delta kW	Ex Ante Delta kW	Delta Watt Ratio	Ex Post EUL	Ex Ante EUL	EUL Ratio
PGE Very Large	4	6,592	6,667	99%	641.5	681.5	94%	9.5	12.6	76%
PGE Large	6	4,420	5,499	80%	89.7	102.2	88%	13.5	11.5	117%
PGE Medium	7	4,590	4,898	94%	14.8	19.1	77%	9.6	11.1	86%
PGE Small	6	2,793	3,607	77%	2.0	2.2	91%	12.8	11.4	113%
Total PGE	**23**	**4,236**	**4,875**	**87%**	**100.8**	**110.1**	**92%**	**11.6**	**11.5**	**101%**
SCE Very Large	3	6,274	7,626	82%	262.0	266.3	98%	8.7	9.6	91%
SCE Large	6	4,482	6,185	72%	148.9	137.1	109%	12.1	8.7	139%
SCE Medium	8	4,346	5,321	82%	29.8	33.0	90%	11.6	9.1	127%
SCE Small	6	3,324	4,085	81%	14.9	16.3	92%	12.4	11.1	112%
Total SCE	**23**	**4,272**	**5,466**	**78%**	**80.7**	**78.5**	**103%**	**11.7**	**9.5**	**124%**
SDGE Very Large	3	7,407	7,441	100%	102.8	104.3	99%	7.9	12.1	65%
SDGE Large	4	6,086	5,726	106%	59.8	65.8	91%	11.5	13.5	85%
SDGE Medium	4	4,496	4,947	91%	32.5	37.5	87%	7.2	9.5	76%
SDGE Small	5	3,141	3,209	98%	6.7	9.2	73%	12.2	14.8	83%
Total SDGE	**16**	**5,200**	**5,211**	**100%**	**46.8**	**51.2**	**91%**	**9.9**	**12.5**	**80%**

5.3.1 Operating Hours

- **PG&E –** At the PA level, ex post operating hours were roughly 13% less than the ex ante assumption. The ex ante and ex post hours are nearly identical in the Very Large census segment. However, the ex post hours for the Large and Small segments were much less than the ex ante claim (20% and 23% less) which contributed to a lower overall ratio at the PA level. In both the pre- and post-case, annual operating hours generally decrease as the size of the projects decrease.
- **SCE –** At the PA level, ex post operating hours were roughly 22% less than the ex ante assumption. The ratio of ex post to ex ante operating hours is very similar when compared across segments and, again, there is a general decrease for both ex ante and ex post hours as the size of the projects decrease.
- **SDG&E –** At the PA level, ex post operating hours are almost identical to the ex ante assumptions. There were several large retail establishments within both the sample and population of SDG&E projects. Pre-monitoring had been done at two of the retail establishments in the Large segment. These hours were very similar to the ex post

adjusted self-report (within 4%), so the monitored hours were used to represent the ex post case. Again, there is a marked reduction in both ex post and ex ante operating hours from the larger strata to the smaller ones.

5.3.2 Delta Wattage

- **PG&E** – At the PA level, the overall ex post baseline to retrofit total installed wattage is roughly 92%. These estimates represent a combination of dual baseline and single baseline measures. For measures that were determined to be ROB, the baseline wattage represents code or industry standard practice wattage and, for ER measures, it represents the baseline associated with the replaced equipment. The PGE Medium segment has the lowest delta ratio (77%) which is driven by several factors including a project where two measures were unaccounted for at the time of the on-site audit. Much like in the discussion regarding operating hours, total delta kW for the ex ante and ex post case drop significantly as the strata size decreases.
- **SCE** – At the PA level, the overall ex post delta kW is roughly 3% greater than the ex ante claim. While the ex post kW for the Small and Medium segments are roughly 8% and 10% lower than the ex ante claim, the PA level result is driven upward by the Large and Very Large projects. Each of these segments represent a distribution of ER/ROB designations as well as a distribution of baseline/retrofit measure types. Again, total delta kW for the ex ante and ex post case drop significantly as the strata size decreases.
- **SDG&E** – At the PA level, the overall ex post delta kW is roughly 9% less than the ex ante claim. The ex post ratios for the Small and Medium segments are less than those for the Large and Very Large segments. For all sampled SDG&E site measures, only one was determined to be ER, so for all measures that were subject to a dual baseline approach, the industry standard practice or code baseline (where applicable) was applied to the evaluated baseline condition.

5.3.3 EUL

- **PG&E** – At the PA level, the ex post EUL was almost identical to the average ex ante claim. At the strata level, the ex post EULs for the Medium and Very Large segments are much lower than the PA average. This is driven primarily by much lower ex post EULs for LED and CFL lamp measures along with an LED fixture measure installed in the largest project in the census category. The higher ex post EULs in the Large and Small segments correspond to lower ex post operating hours.
- **SCE** – At the PA level, the ex post EUL is roughly 24% greater than the ex ante claim. This is driven primarily by LED fixture measures, where the ex post evaluation determined that the service life of many of these measures was in the 50,000 to 60,000 hour range. When the service life was divided by the ex post operating hours, many of

these measures had EULs of 15 years or greater. The ex ante EUL claim for many of these measures was 3 to 5 years. Even in a building type that had high annual operating hours like large retail, the ex ante service life of these measures would be in the 18,000 to 30,000 hour range, much less than what was collected from the manufacturer cut sheet.

- **SDG&E –** At the PA level, the ex post EUL is roughly 20% less than the ex ante claim. As discussed in the operating hour section, the ex post hours in SDG&E were generally higher than ex ante claims which has the effect of reducing the effective useful life of the measure. For example at the measure level, it is evident that the ex ante EULs for LED lamp measures were generally much higher than ex post actuals. The ex post EULs for LED lamps ranged from 5 to 9 years whereas the ex ante claim ranged from 12 to 15 years.

6

Results

This section presents the final results for the 2014 Nonresidential Downstream Custom Lighting Impact Evaluation. Presented are the gross and net realization rates for first year and lifecycle kW and kWh savings, as well as the statewide nonresidential downstream custom lighting ex post population-level savings for first year and lifecycle kW and kWh.

6.1 Gross First Year Realization Rates

Once all the individual parameter estimates were developed for each participant in the on-site sample, and the customer was classified as either ROB/NR/NC or ER, the equation presented in Section 5 was applied to develop project-specific estimates of gross energy savings.

Gross realization rates were then estimated for kWh and kW savings by looking at the ratio of the aggregate evaluated gross savings to the aggregate ex ante gross savings. Specifically, the GRR for PA segment j is estimated as:

$$Gross\_Realization\_Rate_j = \frac{\sum_{i=1}^{n} Gross\_Ex\_Post\_Impact_{i,j}}{\sum_{i=1}^{n} Gross\_Ex\_Ante\_Impact_{i,j}}$$

Where,

> $Gross\_Ex\_Post\_Impact_{i,j}$ is the site-specific gross ex post impact estimate for customer i, in the on-site sample, who is in PA segment j.
>
> $Gross\_Ex\_Ante\_Impact_{i,j}$ is the site-specific gross ex ante impact estimate for customer i, in the on-site sample, who is in PA segment j.[6]

[6] It is important to note that the realization rates are based on the unadjusted ex ante impacts provided in the tracking system, which were not adjusted by the 0.9 realization rate. Had the adjusted ex ante savings values been used, the resulting realization rates would have increased by a factor of one divided by 0.9 (or 11%).

Table 6-2 present the kWh and kW first year gross realization rates along with the corresponding ex ante and ex post first year gross kW and kWh savings for the overall nonresidential custom lighting population, by PA and statewide. The sample sizes and corresponding relative precisions are also shown.

Table 6-1: 2014 Population Level First Year Gross kWh Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Ex Ante Gross MWh Savings	Ex Post Gross MWh Savings	GRR kWh	Sample Relative Precision
PG&E	23	126,615	100,369	79%	4%
SCE	23	133,278	100,332	75%	6%
SDG&E	16	12,423	12,394	100%	5%
Statewide	**62**	**272,316**	**213,094**	**78%**	**4%**

Table 6-2: 2014 Population Level First Year Gross kW Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Ex Ante Gross MW Savings	Ex Post Gross MW Savings	GRR kW	Sample Relative Precision
PG&E	23	16.0	13.0	81%	7%
SCE	23	15.1	11.6	77%	8%
SDG&E	16	2.1	2.3	112%	8%
Statewide	**62**	**33.2**	**27.0**	**81%**	**5%**

As discussed above in Section 5.3 the ex post operating hours and delta wattage for projects completed in PG&E were generally less than the ex ante claim which results in an overall first year kWh and kW GRR of 79% and 81%, respectively. For SCE, the resulting kW and kWh GRRs (75% and 77%) were driven most significantly by lower ex post operating hours. For SDG&E, the ex post operating hours were virtually identical (at the PA level) and delta wattages were very similar to the ex ante assumptions which lends itself to a kWh GRR of roughly 100%. The ex post peak demand savings (especially for the large retail establishments) were also generally higher than ex ante estimates which helps to explain the kW GRR of 112%.

Despite these differences across PAs, the ex post kWh saving values produced GRRs with relative precision that ranged from 4% to 6% at the overall PA level at 90% confidence. At the statewide level, the GRR had a relative precision of 4%.

6.2 Lifecycle Gross Realization Rates

Because many measures have a dual baseline, the gross realization rates associated with the first year savings will differ from the gross realization rates associated with lifecycle savings. To estimate lifecycle savings, annual gross savings were estimated for each year through the measure's EUL and aggregated. No net present valuation was made, just a straight aggregation. For measures classified as ROB, the lifecycle savings equals the first year savings times the EUL. For measures classified as ER, the lifecycle savings equals the annual RUL period savings times the RUL plus the annual post-RUL savings times the EUL minus the RUL:

*ROB Lifecycle savings = EUL * First Year Savings*

*ER Lifecycle savings = RUL * RUL Period Savings + (EUL-RUL) * Post-RUL Savings*

Gross lifecycle realization rates were then estimated by looking at the ratio of the evaluated gross lifecycle savings to the ex ante gross lifecycle savings. Table 6-3 and Table 6-4 present the kWh and kW lifecycle gross realization rates along with the corresponding ex ante and ex post lifecycle gross kW and kWh savings for the overall nonresidential custom lighting population, by PA and statewide. The sample sizes and corresponding relative precisions are also shown.

Table 6-3: 2014 Population Level Lifecycle Gross kWh Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Lifecycle Ex Ante Gross MWh Savings	Lifecycle Ex Post Gross MWh Savings	Lifecycle GRR kWh	Sample Relative Precision
PG&E	23	1,384,575	1,002,849	72%	6%
SCE	23	1,387,300	1,185,469	85%	7%
SDG&E	16	148,038	121,914	82%	4%
Statewide	**62**	**2,919,913**	**2,310,232**	**79%**	**4%**

Table 6-4: 2014 Population Level Lifecycle Gross kW Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Lifecycle Ex Ante Gross MW Savings	Lifecycle Ex Post Gross MW Savings	Lifecycle GRR kW	Sample Relative Precision
PG&E	23	178.0	122.3	69%	8%
SCE	23	165.3*	120.7*	73%	12%
SDG&E	16	25.3*	24.6*	97%	8%
Statewide	**62**	**368.7**	**267.6**	**73%**	**6%**

* Lifecycle kW savings for 7 claims (6 for SCE and 1 for SDG&E) were adjusted by the evaluation team. The 6 SCE claims reported 0 first year kW savings, but claimed lifecycle kW savings. The effect was marginal – ex ante gross MW went from 167.5 to 165.3 and ex post went from 122.6 to 120.7 MW. For the 1 SDG&E claim, first year kWh savings were multiplied by the EUL and this value was applied to the lifecycle kW savings. This effect was significant and the correction changed the ex ante gross MW from 1,742.65 to 25.3 and ex post from 1,299.55 to 24.6 MW.

Overall, the kWh and kW lifecycle GRR for both PG&E (72% and 69%) and SDG&E (82% and 97%) decreased relative to the first year GRRs. These differences are predicated on the distribution of ER versus ROB measures along with the fact that the ex post EULs were generally lower than ex ante assumptions (as a result of higher operating hours). For SCE, the kW GRR was 73% and the kWh increased to 85%. This increase is best explained by the ex post EULs being greater than ex ante assumptions which resulted in the gross impacts extending further out in time.

The ex post kWh saving values produced lifecycle GRRs with relative precision that ranged from 6% to 7% at the overall PA level at 90% confidence. At the statewide level, the kWh GRR had a relative precision of 4%.

6.3 Net First Year Realization Rates

The gross realization rates presented above were based on the on-site sample, however NTGRs were developed for the larger participant phone survey sample. NRRs were calculated by PA as the product of the segment's NTGR and GRR:

$$NRR_j = NTGR_j \ x \ GRR_j$$

Where,

NRR_j is the segment-specific NRR for PA segment j

$NTGR_j$ is the segment-specific NTGR for PA segment j, based on the phone survey sample.

GRR_j is the segment-specific GRR for PA segment j, based on the onsite sample.

Table 6-5 presents the ex ante and ex post NTGR values weighted by ex post kWh and kW savings, by PA and statewide, along with relative precisions. At the PA level, ex post NTGs weighted by kWh range from 0.47 in SCE to 0.55 in SDG&E. While the ex post NTGs do not vary significantly across PAs, they do when compared to the ex ante values. For PG&E and SCE, the ex post kWh NTGs for the smaller projects (<50,000 kWh savings for PG&E and <75,000 kWh savings for SCE) were lower than any other sample segment for each PA at 0.44 and 0.37, respectively. This is compared to 0.71 for each PA at the very large segment level. For each of these PAs, indoor and outdoor LED fixture retrofit projects also represented a significant share of net project interviews completed (34 of 67 interviews in PG&E and 26 of 56 interviews in SCE). These types of projects, which included city street lights, billboards and parking lots, generally had kWh NTGs in the 0.44 to 0.49 range. In SCE, the ex ante NTG for all these projects was 0.85 which is significantly greater than what was collected as part of the ex post net interviews. For SDG&E, the very large segment had the highest kWh weighted NTG (.69), which was based on a sample size of 2 and the large segment had the lowest at 0.43. This segment was represented by large corporate retail establishments and a federal military facility. Overall, at the statewide level, the ex post NTGRs are roughly 30% less than the ex ante values.

Table 6-5: Comparison of Ex ante and Ex post NTGRs by PA with Relative Precisions, Weighted by kWh and kW Savings

Program Administrator	Sample Size	kWh Weighted Results			kW Weighted Results		
		Ex Ante NTGR	Ex Post NTGR	RP	Ex Ante NTGR	Ex Post NTGR	RP
PG&E	67	0.64	0.51	7%	0.65	0.52	6%
SCE	56	0.76	0.47	9%	0.73	0.46	8%
SDG&E	18	0.61	0.55	12%	0.61	0.61	10%
Statewide	**141**	**0.69**	**0.49**	**5%**	**0.68**	**0.51**	**4%**

Table 6-6 and Table 6-7 present the kWh and kW first year net realization rates along with the corresponding ex ante and ex post first year net kW and kWh savings for the overall nonresidential custom lighting population, by PA and statewide. The sample sizes and corresponding relative precisions are also shown.

Table 6-6: 2014 Population Level First Year Net kWh Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Ex Ante Net MWh Savings	Ex Post Net MWh Savings	NRR kWh	Sample Relative Precision
PG&E	23	80,182	50,715	63%	9%
SCE	23	102,381	47,144	46%	11%
SDG&E	16	7,619	6,807	89%	13%
Statewide	**62**	**190,181**	**104,666**	**55%**	**6%**

Table 6-7: 2014 Population Level First Year Net kW Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Ex Ante Net MW Savings	Ex Post Net MW Savings	NRR kW	Sample Relative Precision
PG&E	23	10.2	6.8	66%	9%
SCE	23	11.2	5.3	47%	11%
SDG&E	16	1.3	1.4	112%	13%
Statewide	**62**	**22.7**	**13.5**	**59%**	**6%**

The NRRs differ from the GRRs due to differences between the ex post and ex ante NTGRs. For PG&E and SCE, the ex post NTGRs are less than the ex ante NTGRs, which explains why the NRRs are lower than the GRRs. The SDG&E first year kW NRR is almost identical to the first year GRR because the ex post NTG was almost identical to the ex ante NTG.

Overall, the ex post gross savings and NTG produced kWh NRRs with relative precision that ranged from 9% to 13% at the overall PA level at 90% confidence. At the statewide level, the NRR had a relative precision of 6%.

6.4 Lifecycle Net Realization Rates

Lifecycle NRRs were estimated in a similar way as lifecycle GRRs, by looking at the ratio of the evaluated ex post net lifecycle savings to the ex ante net lifecycle savings. The approach is identical to that for the lifecycle GRRs, but using net savings instead of gross.

Table 6-8 and Table 6-9 present the kWh and kW lifecycle NRRs along with the corresponding ex ante and ex post lifecycle net kW and kWh savings for the overall nonresidential custom lighting population, by PA and statewide. The sample sizes and corresponding relative precisions are also shown.

Table 6-8: 2014 Population Level Lifecycle Net kWh Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Lifecycle Ex Ante Net MWh Savings	Lifecycle Ex Post Net MWh Savings	Lifecycle NRR kWh	Sample Relative Precision
PG&E	23	879,476	506,731	58%	9%
SCE	23	1,050,326	557,025	53%	11%
SDG&E	16	89,849	66,958	75%	13%
Statewide	**62**	**2,019,652**	**1,130,714**	**56%**	**7%**

Table 6-9: 2014 Population Level Lifecycle Net kW Realization Rates and Sample Relative Precisions by PA

Program Administrator	Sample Size	Lifecycle Ex Ante Net MW Savings	Lifecycle Ex Post Net MW Savings	Lifecycle NRR kW	Sample Relative Precision
PG&E	23	114.1	63.6	56%	10%
SCE	23	120.5	55.1	46%	14%
SDG&E	16	15.4	15.1	98%	13%
Statewide	**62**	**250.0**	**133.9**	**54%**	**8%**

* Lifecycle kW savings for 7 claims (6 for SCE and 1 For SDG&E) were adjusted by the evaluation team. The 6 SCE claims reported 0 first year kW savings, but claimed lifecycle kW savings. The effect was marginal – ex ante net MW went from 121.8 to 120.5 and ex post went from 56.0 to 55.1 MW. For the 1 SDG&E claim, first year kWh savings were multiplied by the EUL and this value was applied to the lifecycle kW savings. This effect was significant and the correction changed the ex ante net MW from 1,045.8 to 15.4 and ex post from 798.0 to 15.1 MW.

The objective of this study was to develop lifecycle NRRs that could be used to estimate IOU level savings across all nonresidential custom lighting measures that are statistically significant. The ex post kWh saving values produced lifecycle kWh NRRs with relative precision that ranged from 9% to 13% at the overall PA level at 90% confidence and kW NRRs at the 10% to 14% range. At the statewide level, the lifecycle kWh NRR had a relative precision of 7%, compared to the target of 90/20 and the lifecycle kW NRR has a relative precision of 8%.

7

Conclusions and Recommendations

This section presents recommendations related to the findings developed for this evaluation. Recommendations are typically associated with specific parameters that comprise the energy savings calculations.

Conclusion 1: Projects that claim a program-induced early retirement do not always provide sufficient documentation to justify early replacement.

Recommendation 1: Projects that claim a program-induced early retirement must provide sufficient documentation to justify early replacement (ER). Each project claiming early replacement should provide a narrative description justifying that classification, including documenting the age and condition of the replaced equipment, using the criteria provided in the CPUC draft guidance document "Project Basis (RET, ROB, etc.), EUL/RUL Definitions, & Preponderance of Evidence" dated 1/29/14.[7]

Conclusion 2: Program tracking data is sometimes incorrectly reporting RULs for early replacement projects. For some early replacement projects with a dual baseline, the tracking system was reporting RULs that were equal to the EUL. The lifecycle savings were calculated for the full EUL period (akin to an ROB calculation). Some of these projects had a significant reduction in annual savings for the post-RUL which were not captured in the ex ante savings. The project applications correctly identified the second baseline savings, but they were not being accounted for because of the incorrect application of the RUL.

Recommendation 2: Program tracking data that correspond to early replacement projects using a dual baseline should ensure that the reported RUL does not equal the reported EUL.

Conclusion 3: Programs installing dual baseline measures can influence both the timing and the efficiency of the measure installed. During the RUL period, both timing and efficiency can be influenced by the program; however during the post-RUL period, the program can only influence the efficiency of the installed equipment.

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7 http://www.energydataweb.com/cpuc/deliverableView.aspx?did=1035&uid=0&tid=0&cid=

Recommendation 3: Further research should be done to consider a framework for NTGRs that can be applied to measures that have a dual baseline, where separate NTGRs are developed for the RUL and post-RUL periods to incorporate the program's influence on both the timing and efficiency of the installed equipment.