Itron
Knowledge to Shape Your Future

Electric | Gas | Water
information collection, analysis and application

CALMAC Study ID: CPU0019.01

# Small Commercial Contract Group Direct Impact Evaluation Report


Prepared by
**Itron, Inc.**
**ECONorthwest**
**KEMA Inc.**
**PA Consulting**
**Summit Blue**
**Robert Thomas Brown Co.**

For the
**California Public UtilitiesCommission**
**Energy Division**

February 9, 2010

# Table of Contents

# Abstract

This document was prepared by the Small Commercial Evaluation Team (team), led by Itron Inc. for the California Public Utilities Commission (CPUC). Other members of the Evaluation Team are EcoNorthwest, KEMA, Inc., PA Consulting, Robert Thomas Brown, and Summit Blue Consulting. This document describes the evaluation efforts conducted by the team in evaluating the small commercial energy efficiency lighting technology high impact measures (HIMs) and non-HIMs offered by programs run by the IOUs in the State of California, and the resulting findings and recommendations. These HIMs—linear fluorescents, high bay lighting, downstream and upstream CFL, and occupancy sensors—accounted for at least 1% of portfolio savings claimed by the IOUs during the 2006-2008 program cycle. A more limited evaluation was performed for a number of other measures (non-HIMs), such that all measures in the small commercial set of programs were evaluated.

This evaluation was conducted under the rules specified in the CPUC EM&V Protocols and the CPUC Energy Division Final HIM Guidance Memo. It focused on portfolio-level upstream and prescriptive HIMs, which allowed for common evaluation approaches across the HIM measure groups. It offers both a retrospective assessment and prospective guidance in shaping the current rebate programs for small and medium-sized nonresidential customers.

The major objectives of the impact evaluation of the HIMs and non-HIMs are to estimate the energy and demand savings, produced by the HIMs and non-HIMs; to conduct research to inform the Commission's energy efficiency policy and program planning needs; and provide feedback to program administrators and implementers for the purpose of improving programs. These key parameter estimates are significant elements in determining the accuracy of the earnings claims by the IOUs in California.

To meet these objectives, several key parameters are examined. These include verification/installation rates, kW and kWh unit energy savings values, baseline and post hours of use values, baseline and post wattage values, and net-to-gross ratios using a combination of self-reported data, onsite verification data, metered data, billing and discrete choice analyses. The study provides results and recommendations for gross and net savings for five HIMs and non-HIMs.

# 1

# Executive Summary

This report describes the evaluation of the 2006-2008 nonresidential energy efficiency high impact lighting measures. These measures were offered by programs implemented by Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas and Electric (SDG&E) and third party implementers for the 2006-2008 program cycle. This evaluation was conducted by the Small Commercial Contract Group Evaluation Team[1] under the rules specified in the CPUC EM&V Protocols and the CPUC Energy Division (ED). This report describes the full impact evaluation efforts and the resulting findings and recommendations.[2]

The evaluation efforts focused on lighting technology high impact measures (HIMs) with common program elements and integrated marketing approaches, which allowed for common evaluation approaches across the HIM measure groups. These HIMs accounted for at least 1% of portfolio savings claimed by the IOUs during the 2006-2008 program cycle. A number of other nonresidential measures with lesser savings, termed non-HIMs, were also evaluated in this report. Table 1-1 shows the list of HIMs and non-HIMs included in the evaluation.

The major objectives of the impact evaluation are to estimate the energy and demand impacts produced by the HIMs and non-HIMs, to conduct research to inform the Commission's energy efficiency policy and program planning needs, and to provide feedback to program administrators and implementers in order to improve programs. To meet these objectives, several research activities were conducted to estimate a number of energy-savings-related parameters. These include verification/installation rates, kW and kWh unit energy savings (UES) values, baseline and post-hours-of-use values, baseline and post-wattage values, and

---

1 The Small Commercial Contract Group evaluation team is comprised of Itron Inc, ECONorthwest, KEMA Inc, PA Consulting, Robert Thomas Brown Company, and Summit Blue.

2 The Small Commercial Contract Group also performed a verification-level analysis for the 2006-2007 program cycle. This report can be found at:

http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/081117_Verification+Report.htm. California Public Utilities Commission. *Energy Efficiency 2006-2007 Verification Report*. Prepared by the Energy Division. 2009.

net-to-gross ratios using a combination of self-reported data, on-site verification data, metered data, billing and discrete choice analyses.

**Table 1-1: High Impact, Non-High Impact Measures and Programs**

| High Impact Measure (HIM) | Non-HIM |
|---|---|
| Upstream Interior Screw Lighting | Boiler |
| Interior Screw Lighting | Other : LED exit signs, clothes washers, VFDs |
| High Bay Fluorescent | Miscellaneous food svcs, HVAC, motors |
| Linear Fluorescent | Miscellaneous refrigeration |
| Occupancy Sensor | |
| **Programs Included in Evaluation** | |
| PGE2016 - PG&E Association of Monterey Bay Area Gov't (AMBAG) Program | |
| PGE2017 - PG&E Bakersfield and Kern Energy Watch Program | |
| PGE2021 – PG&E Fresno Energy Watch Program | |
| PGE2054 – PG&E Energy Fitness (RHA) Program | |
| PGE2080 – PG&E Nonresidential Mass Market Program | |
| SCE2511 – SCE Nonresidential Direct Installation Program | |
| SCE2517 – SCE Business Incentives and Services | |
| SDGE 3012 – SDG&E Express Efficiency Program | |
| SDGE 3020 – SDG&E Small Business Super Saver Program | |

## 1.1 Key Findings

Three distinct evaluation activities were performed, as summarized below.

***Verification Analysis.*** The objective of this analysis was to develop an installation rate, which is the percentage of fixtures and lamps found to be in place and operable. An analysis of on-site data was conducted to determine the percentage of rebated measures that were actually installed and operable (this included an assessment of the number of CFLs that were placed in storage and for upstream CFLs, the number that had burned out). Installation rates were estimated by IOU, program and HIM.

***Gross Energy Savings Analysis.*** The primary objective of this activity was to develop gross UES values for four of the five HIMs (all but occupancy sensors).[3] A statewide lighting logger study was performed that collected time-of-use information on over 1,000 nonresidential sites, as well as collecting information on the wattage of installed measures

[3] Two gross impact analysis approaches were attempted for occupancy sensors, but either the analysis provided statistically insignificant results, or data collection efforts were unsuccessful in obtaining sufficient data to produce reliable results

and the wattage of replaced measures. This allowed for estimates of annual hours of use, the percentage of measures on during the peak period and changes in wattage that were used to develop kW and kWh UES values.

***Net-To-Gross Analysis.*** The objective of this analysis was to develop net-to-gross ratios (NTGR) for all HIMs and non-HIMs. A self-report methodology was utilized that was developed by the Standard Nonresidential NTGR working group, which is comprised of Energy Division and its technical consultants and evaluators. The methodology estimated four separate measurements of free ridership from different inquiry routes and then averaged the values to derive the final free ridership estimate at the measure level.

Table 1-2 and Table 1-3 summarize the results of the above analysis at the IOU level for linear fluorescents, high bay fluorescents, and interior screw lighting, for GWh and MW savings, respectively. These tables include the total ex-ante gross savings, total ex-post gross savings, the gross realization rate (the ratio of ex post to ex ante savings), the installation rate, the installed ex-post savings, the NTGR and the resulting installed ex post net savings.

**Table 1-2: Summary of GWh Results for Linear Fluorescents, High Bay Fluorescents, and Interior Screw Lighting**

| HIM | IOU | Ex-Ante Gross Savings GWh | Ex-Post Gross Savings GWh | Gross Realization Rate | Installed Ex-Post Gross Savings GWh | Install Rate | Installed Ex-Post Net Savings GWh | Ex-Post NTGR |
|---|---|---|---|---|---|---|---|---|
| Interior Screw Lighting | PG&E | 141.8 | 40.8 | 29% | 32.1 | 79% | 19.0 | 59% |
| | SCE | 145.4 | 49.2 | 34% | 30.7 | 63% | 18.6 | 61% |
| | SDG&E | 34.6 | 5.2 | 15% | 4.1 | 78% | 3.5 | 85% |
| High Bay Fluorescent | PG&E | 67.6 | 46.8 | 69% | 42.9 | 92% | 29.2 | 68% |
| | SCE | 46.6 | 34.5 | 74% | 32.3 | 93% | 22.0 | 68% |
| | SDG&E | 29.7 | 16.3 | 55% | 16.3 | 100% | 15.5 | 95% |
| Linear Fluorescent | PG&E | 82.1 | 62.3 | 76% | 57.1 | 92% | 41.7 | 73% |
| | SCE | 301.9 | 212.3 | 70% | 201.5 | 95% | 158.6 | 79% |
| | SDG&E | 169.2 | 74.4 | 44% | 66.9 | 90% | 58.3 | 87% |

### Table 1-3: Summary of MW Results for Linear Fluorescents, High Bay Fluorescents, and Interior Screw Lighting

| HIM | IOU | Ex-Ante Gross Savings MW | Ex-Post Gross Savings MW | Gross Realization Rate | Installed Ex-Post Gross Savings MW | Install Rate | Installed Ex-Post Net Savings MW | Ex-Post NTGR |
|---|---|---|---|---|---|---|---|---|
| Interior Screw Lighting | PG&E | 18.1 | 5.7 | 31% | 4.4 | 78% | 2.7 | 62% |
| | SCE | 27.3 | 7.2 | 26% | 4.5 | 63% | 2.9 | 64% |
| | SDG&E | 6.1 | 0.5 | 9% | 0.4 | 76% | 0.3 | 83% |
| High Bay Fluorescent | PG&E | 19.6 | 9.7 | 49% | 8.9 | 92% | 6.1 | 68% |
| | SCE | 14.3 | 7.8 | 55% | 7.3 | 93% | 5.1 | 70% |
| | SDG&E | 6.0 | 3.5 | 58% | 3.5 | 100% | 3.3 | 95% |
| Linear Fluorescent | PG&E | 18.7 | 14.7 | 79% | 13.5 | 92% | 10.0 | 74% |
| | SCE | 66.2 | 52.1 | 79% | 49.4 | 95% | 39.1 | 79% |
| | SDG&E | 36.2 | 19.1 | 53% | 17.3 | 90% | 15.1 | 87% |

The Residential Retrofit Contract Group (RRCG) was responsible for developing the overall net energy savings values for upstream interior screw lighting, and the SCCG was responsible for developing kW and kWh unit energy savings. Table 1-4 summarizes the kW and kWh UES values developed as part of this evaluation for nonresidential upstream interior screw lighting.[4]

### Table 1-4: Summary of kW and kWh UES Values for Nonresidential Upstream Interior Screw Lighting

| IOU | Operating Hours | Coincident Peak | Pre-Wattage | Post-Wattage | Ex Post UES kWh | Ex Post UES kW |
|---|---|---|---|---|---|---|
| PG&E | 2,710 | 44% | 62.8 | 18.2 | 121 | 0.020 |
| SCE | 2,517 | 39% | 57.3 | 15.5 | 105 | 0.016 |
| SDG&E | 2,191 | 36% | 63.0 | 17.9 | 99 | 0.016 |

Finally, verification analysis and the lighting logger analysis were not performed for occupancy sensors or the non-HIMs, only the net-to-gross analysis was performed. Therefore, Table 1-5 summarizes the NTGRs for occupancy sensors and the non-HIMs.

4 Please note that Table 1-4 only presents the nonresidential UES values for upstream interior screw lighting. Please refer to the Upstream Lighting Evaluation Report for a presentation of the full set of gross and net energy savings results for both residential and nonresidential upstream interior screw lighting.

**Table 1-5: Summary of NTGRs for Occupancy Sensors and Non-HIMs**

| HIM | IOU | Ex-Ante Gross Savings | Ex- Ante Net Savings | Ex-Ante NTGR | Ex-Post Net Savings | Ex-Post NTGR |
|---|---|---|---|---|---|---|
| GWH | | | | | | |
| Occupancy Sensor | PG&E | 27.4 | 26.3 | 96% | 18.6 | 68% |
| | SDG&E | 29.2 | 28.0 | 96% | 22.0 | 75% |
| Other – Non-HIMs | PG&E | 190.4 | 179.5 | 94% | 64.7 | 34% |
| | SCE | 14.9 | 14.3 | 96% | 13.4 | 90% |
| | SDG&E | 28.8 | 27.7 | 96% | 16.7 | 58% |
| MW | | | | | | |
| Occupancy Sensor | PG&E | 6.3 | 6.0 | 96% | 4.4 | 70% |
| | SDG&E | 6.0 | 5.7 | 96% | 3.6 | 60% |
| Other – Non-HIMs | PG&E | 75.8 | 72.3 | 95% | 32.6 | 43% |
| | SCE | 1.3 | 1.3 | 96% | 1.1 | 87% |
| | SDG&E | 2.6 | 2.5 | 96% | 1.4 | 53% |
| Millions of Therms | | | | | | |
| Occupancy Sensor | PG&E | 0.89 | 0.85 | 96% | 0.32 | 36% |
| Other – Non-HIMs | PG&E | 1.92 | 1.85 | 96% | 1.82 | 95% |
| | SoCalGas | 1.54 | 1.48 | 96% | 0.49 | 32% |
| | SDG&E | 0.31 | 0.29 | 96% | 0.00 | 1% |

## 1.2 Key Recommendations

Key net and gross impact parameter results were examined by market segment in order to identify market segments that are good candidates to target or avoid in the future.

- ***Linear Fluorescent Segments to Target***. Grocery and restaurants are two market segments that are likely to provide higher energy savings, relative to the other market segments.
- ***Linear Fluorescent Segments to Potentially Avoid***. Assembly is likely to provide lower energy savings, both based on its low verification rate and lower operating hours relative to the other market segments.
- ***CFL Segments to Target***. Targeting the specific large single-story retailer that had large lighting displays retrofitted was clearly a success, providing high operating hours and resulting energy savings. This model could be emulated for other large retailers with large lighting displays. Other market segments that could be candidates for targeting based on their operating hours are small retail and restaurants. Unfortunately, the retail segments exhibited low verification rates. Therefore,

programs targeting these segments should utilize on-site inspections to ensure higher installation rates.

- ***CFL Segments to Potentially Avoid***. The lodging segment is the lowest relative performer with the highest rate of free ridership and the lowest operating hours. This is also one of the largest participating segments, accounting for about a quarter of the CFLs overall and nearly 40% of the downstream CFLs.

Furthermore, based on the lessons learned from this evaluation, the following recommendations are provided to guide future evaluation efforts.

- ***Program Tracking Data Issues.*** Measure names should be more consistent across programs and utilities. Information on the replaced equipment should be documented. More accurate installation dates should be recorded, as well as all of the meters impacted by the retrofit instead of just one meter.
- ***Verification Analysis.*** Verification results for nonresidential lighting should be based on data collected on site, which is much more reliable than data collected over the phone. On-sites should be conducted relatively soon after the customer installs the measure to accurately estimate burn out and storage rates, and improve customer recall on the disposition of rebated measures.
- ***Lighting Logger Equipment and Quality Control Issues.*** Equipment should be thoroughly inspected to ensure the internal time clock is accurate, magnets are securely attached, battery life is sufficient and the light sensitivity is adequate. To improve data quality and assist in the data validation process, photos should be taken at the site, and backup or redundant loggers should be installed.
- ***Dual Baseline for Linear Fluorescents***. The majority of linear fluorescents rebated through the programs are early replacement, rather than a replacement on burnout. Therefore, future evaluations should consider a dual baseline for this measure, where the existing equipment is treated as the baseline for the remaining useful life of the replaced equipment. For years beyond the remaining useful life, through the measure’s effective useful life, the baseline would be set equal to minimum code requirements.
- ***Net-to-Gross Analysis.*** Surveys should be conducted in waves, soon after customers participate to both improve customer recall, and provide program implementers with early feedback to allow for program design changes to be made during the program cycle.

# 2

# Introduction and Purpose of Study

## 2.1 Background

This report documents the evaluation activities undertaken by the Small Commercial Contract Group (SCCG), which focused on five lighting technology high impact measures (HIMs) and non-HIMs across all energy efficiency programs offered in 2006-2008 by the four investor-owned utilities (IOUs)—Pacific Gas & Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company (SCG), and San Diego Gas & Electric Company (SDG&E)—and several third party contractors that target medium, small, and very small commercial, industrial and institutional commercial customers statewide and within each IOU's service territory. High impact measures are defined as those efficiency measures common across IOU programs that contribute greater than one percent to the entire IOU savings portfolio for reductions in electrical consumption, electrical demand or natural gas consumption. These measures are offered under programs that provide rebates and a menu of similar energy efficient products and/or services.

The statewide evaluation of the 2006-2008 program cycle lighting technology HIMs and non-HIMs offers both a retrospective examination and a prospective guidance in shaping current offerings for lighting technologies for small and medium-sized nonresidential customers, and meets the objectives set forth by the California Evaluation Protocols[1] and the CPUC ED.

A list of the lighting technology HIMs and non-HIMs included in the SCCG evaluation is shown below in Table 2-1. The "Other" non-HIMs include the following miscellaneous types of measures: anti-sweat heater controls, commercial clothes washers, cooler door auto closers, commercial pool heaters, convection ovens, ECM evaporator fan motors, HVAC fan variable frequency drives, gas hot water boilers, gas storage water heaters, ice machines, instantaneous gas water heaters, LED exit signs, network management software, and vending machine controllers.

---

[1] *California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals.* Prepared by TecMarket Works for the California Public Utilities Commission. April 2006.

**Table 2-1: List of HIMs and Non-HIMs Included in Evaluation**

| High Impact Measure (HIM) | Non-HIM |
|---|---|
| Upstream Interior Screw Lighting | Boiler |
| Interior Screw Lighting | Other |
| High Bay Lighting | |
| Linear Fluorescent | |
| Occupancy Sensors | |

The original evaluation plan[2] highlighted key measures for each of the top performing program—PGE2080, SCE2511, SCG3507, SDGE3012, and SDGE3020—and assigned a level of rigor and data collection activities for each key measure-program combination. Each measure subsequently became a HIM and, therefore, is covered by one of the HIM evaluations. Consequently, the HIM approach does not represent a significant change in the SCCG's evaluation plan. The only change results in the HIM evaluations being conducted at the IOU level, not the program level.

## 2.2 Purpose of Study

The primary purpose of this study is to provide an evaluation of the California IOUs' claimed energy efficient accomplishments for the 2006-2008 program cycle. The study focuses primarily on portfolio level upstream and prescriptive HIMs as identified by the IOUs filed cumulative savings reports for the same period. This involves estimating gross and net kW and kWh savings over the lifetime of the measures, and developing impact load shapes. It is also important to note that HIM evaluations serve many other purposes including improving the programs, supporting the cost-effectiveness analyses, providing data for future programs and strategic planning.

### *2.2.1 Overview of EM&V Activities*

The prescriptive nature of these HIMs along with the common program elements and integrated marketing approaches allow for common evaluation approaches across the group of lighting technology HIMs. The following sections describe the EM&V activities conducted by the team.

[2] *Small Commercial Contract Group Direct Impact Evaluation*, July 16, 2008, Table 8-2 page 41; and *Small Commercial Contract Group High Impact Measure Evaluation Plan*, April 6, 2009, Table 6 page 9.

***Verification of Measure Installation***

The primary purpose of the verification assessment is to verify the IOUs' reported measure installations for claimed energy efficient accomplishments from January 1, 2006 through December 31, 2008. This task is accomplished utilizing on-site data collection to determine the percent of measures actually installed, in place and operable at the premise. This task was conducted for all HIMs evaluated under this SCCG; however, on-site verification was not performed for the non-HIM measures. For CFLs, storage rates (the percent of lamps placed in storage for future use) were also estimated.

***Gross Impact Analysis Approach***

The primary objective of this activity is to develop gross unit energy savings values for four of the five HIMs (all but occupancy sensors). In addition to the use of time of use (TOU) lighting loggers, this analysis was supported by telephone and on-site verification survey collection, and pre- and post-spot watt measurements and pre- and post-logging to determine changes in pre/post operating hours. For linear fluorescent and high bay measures, these savings were statistically adjusted through a billing analysis. In addition to the estimate of unit energy savings for these four HIMs, an estimate of hours of operations was also developed. Furthermore, for upstream CFLs, an estimate of the distribution (or split) between residential and nonresidential installations was developed.

For occupancy sensors and the non-HIM measures studied, the 2008 DEER (revised DEER) values and appropriate DEER load shapes are applied to the ex ante savings. Measures not studied or included in the DEER update will be assigned a default realization rate defined by the ED.

***Net-to-Gross (Net of Free Rider) Assessment***

For all HIMs and non-HIMs, the self-report NTG ratios were developed on a program and measure-level basis using the guidance provided by the evaluation protocols. The methodology was developed by the Standard Nonresidential NTGR working group, which was formed to craft consistent batteries of questions that were used in surveys. Building on lessons learned in past evaluations and the experience of contractors, the group developed batteries of questions and associated scoring algorithms for calculating NTGRs. In addition to using the self-report approach, a discrete choice analysis was implemented for the linear fluorescent and high bay lighting HIMs, which utilized a large sample of participant and nonparticipant telephone surveys.

Table 2-2 summarizes the EM&V activities and the savings parameters for which evaluation results are reported.

**Table 2-2: High Impact Measure Evaluation Activities**

| | Verification | | Gross Savings | | | | Net Savings | |
|---|---|---|---|---|---|---|---|---|
| | | | Telephone Survey | | Field Measurement | | | |
| | | | Billing and Weather Data | | | | | |
| Data Collection Activities and Evaluation Methods | On-Site Audits | | Billing Analysis | Res/NonRes Upstream Split Analysis | TOU Loggers | Spot Watt Meters | Participant Self Report | Discrete Choice |
| Measure Groups | UES Verification Rate | CFL Installation Rate/ Storage Rate | Realization Rates | CFL Split Estimate | Hours of Use, UES, Placement | UES | NTG Ratio | NTG Ratio |
| **HIM** | | | | | | | | |
| Linear Fluorescent | ● | | ● | | ● | ● | ● | ● |
| High Bay Fluorescent | ● | | ● | | ● | ● | ● | ● |
| Interior Screw Lighting | ● | ● | | | ● | ● | ● | |
| Upstream Interior Screw Lighting | | ● | | ● | ● | ● | ● | |
| Occupancy Sensor | ● | | | | | | ● | |
| **Non-HIM** | | | | | | | | |
| Boilers | | | | | | | ● | |
| Other | | | | | | | ● | |

### *2.2.2 Programs (HIM or non-HIM) Included in Evaluation*

The HIMs studied as part of this evaluation were offered by a number of programs implemented during the 2006-2008 period. The samples for the telephone, on-site, and logger data collection activities were drawn from a number of these programs, primarily the programs that had the largest installation of these HIMs. Furthermore, there were five programs from which non-HIM participants were surveyed for the development of free-ridership estimates.

The upstream lighting program (ULP) is a key component within PG&E, SCE, and SDG&E's program portfolios and differs significantly from the downstream (directly to customers) lighting programs. The ULP provides manufacturer and distributor buy-downs or retailer instant discounts for eligible lighting products that were then sold through participating retailers.

The programs from which samples were drawn to support this evaluation, brief descriptions, and their basic program elements are presented in Table 2-3.

## Table 2-3: Small Commercial HIM Programs Included in Evaluation

| Programs Included in this Evaluation | Program Description | Key Program Elements |
|---|---|---|
| PG&E - Association of Monterey Bay Area Governments (AMBAG) Energy Watch (PGE2016) | This program promotes reduced energy use and energy savings targets for the AMBAG member jurisdictions (Monterey, Santa Cruz, and San Benito counties) by providing energy efficiency information and direct installation of energy efficient equipment to eligible residential and small business customers. | Partnership offers lighting technology measures and targets single family and multifamily—(Residential Direct Install and Home Buyers Component), Small Hospitality Business Direct Install, and municipal (city and county) energy efficiency services and incentives for municipal buildings. |
| PG&E - Bakersfield and Kern County Energy Watch (PGE2017) | This partnership is a cooperative effort of Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and Southern California Gas Company (SCG). Partnership offerings are available to residents, businesses, and the municipalities of the City of Bakersfield and Kern County. | The partnership provides energy efficiency information and direct installation of energy efficient equipment to single family and multifamily residential, small business, and municipal (city and county) retrofits in targeted areas, including training to city building inspectors. |
| PG&E - Fresno Energy Watch (FEW) (PGE2021) | The FEW program promotes reduced energy use and energy savings targets for the City of Fresno by providing information and direct installation of energy efficient equipment free of charge to eligible customers (residential and small business customers). | FEW provide energy audits and direct install of energy saving measures to mass market customers, enhanced incentives to municipal facilities, and a targeted information/education component. |
| PG&E - PG&E Energy Fitness (RHA) (PGE2054) | The Energy Fitness Program, a third party program, serves small and medium size nonresidential PG&E customers in the area north of Sacramento with a no-cost direct install program. | Audits are conducted at each facility and applicable recommendations are made for lighting, refrigeration, HVAC, motors, building envelope, and food service technologies. |
| PG&E - Commercial Mass Market (PGE2080) | The program uses PG&E, third party specialists, and local government partnerships to deliver a portfolio of energy efficiency, demand response, and distributed generation services to single family and multifamily residential customers, commercial renters, and commercial customers. | Program includes statewide elements as well as elements specifically targeted to mass market customers. Program offers the following measures/technologies: AC tune-ups, duct leakage sealing, lighting technologies, cool roof, HE water heaters, pipe insulation, and food service technologies. |
| SCE - Nonresidential Direct Installation Program (SCE2511) | The NRDI delivers energy efficiency hardware offers retrofits to very small and small commercial/industrial businesses through two installation contractors that offer turnkey partnerships with third party (CBOs, FBOs) implementers. | The program provides customers with a single source for information, technical assistance, and financial incentives and installs interior lighting (hardwired, CFLs, screw-in) and refrigeration measures |
| SCE - Business Incentive & Service (SCE2517) | SCE's Business Incentives & Services package integrates several previously stand-alone programs: Express Efficiency Program (statewide itemized (prescriptive) measures), Standard Performance Contract Program (statewide calculated and custom incentives from this statewide program), and Nonresidential Audits (on-site audit activities). | This integrated package of programs offers a full range of solutions, including audits, design assistance, and incentives for qualifying measures to all nonresidential customers, from the smallest GS-1 customer to the largest time-of-use (TOU) commercial or industrial customer. |
| SDG&E - Express Efficiency (SDGE3012) | SDGE Express Efficiency is a statewide prescriptive rebate program that encourages nonresidential customers (monthly demand above 100 kW and/or an average monthly gas usage of 4,166 therms and above) to retrofit existing equipment with high efficiency equipment. | Program offers refrigeration technologies, interior (hardwired), and exterior lighting, HE motors and HE water heaters. The program will use multiple marketing channels to increase awareness and participation in the program. It encourages program delivery by CBOs and FBOs of value-added services. |
| SDG&E - Small Business Super Saver (SDGE3020) | The Small Business Super Saver (SBSS) is a local prescriptive rebate program that encourages nonresidential customers (under 100kW of monthly demand and/or under an average monthly usage of 4,166 therms) to retrofit existing equipment with high efficiency equipment. | The program offers food service and refrigeration technologies, lighting technologies, and other process technologies. It integrates contractor incentives for the very small customer and/or an incentive for comprehensive retrofits. Program offers an On-Bill Financing opportunity for customers who qualify. |

# 3

# Study Objectives and Methodology

## 3.1 Evaluation Objectives

The major objectives of the impact evaluation of the HIMs and non-HIMs are to (1) estimate the energy and demand impacts produced by the HIMs, and (2) conduct research to inform the Commission's energy efficiency policy and program planning needs and provide feedback to program administrators and implementers in order to improve programs.

To meet these objectives, several key parameters are examined. These include verification/installation rates, kW and kWh unit energy savings values, baseline and post-retrofit hours of use values, baseline and post wattage values, and net-to-gross ratios for as many measures in each of the five HIM categories as possible using a combination of self-reported data, measured data, and billing and discrete choice analyses.

The evaluation of the nonresidential upstream interior screw lighting (upstream CFLs) HIM was conducted in close coordination with the Residential Retrofit Contract Group (RRCG). The estimation of nonresidential kW and kWh unit energy savings values (including estimating wattages and hours of use) was conducted solely by the Small Commercial Contract Group (SCCG), as were estimates for installation rates and storage rates (for nonresidential upstream CFLs). The results are presented in this evaluation. Other key parameters estimated for the nonresidential upstream HIM were the residential/nonresidential distribution of installations and net-to-gross ratios. The SCCG team collected telephone survey data to support the final estimates for these two parameters. However, the results are presented in the Upstream Lighting Report as the RRCG utilized additional information collected as part of their evaluation efforts in developing the final residential/nonresidential distribution of installations and net-to-gross ratios.

Table 3-1 shows the key inputs that are estimated for the five HIMs and non-HIM.

**Table 3-1: Major Parameters Examined in the Evaluation**

| Inputs for PEB | HIMs | | | | | Non-HIMs |
|---|---|---|---|---|---|---|
| | Linear Fluorescent | High Bay Lighting | Interior Screw Lighting | Upstream Interior Screw lighting | Occupancy Sensors | PGE2080 SCE2511 SCG3507 SDGE3012 SDGE3020 |
| Verification/Installation Rates | • | • | • | | | |
| Verification/Installation/Storage Rates | | | | • | | |
| Residential/Nonresidential Distribution of Installations | | | | • | | |
| kW UES Values | • | • | • | • | | |
| kWh UES Values | • | • | • | • | | |
| Baseline & Post Hours of Op | • | • | • | • | | |
| Baseline and Post wattage values | • | • | • | • | | |
| Net-to-Gross Ratios | • | • | • | • | • | • |

## 3.2 Overview of Evaluation Activities

This section begins by summarizing the overall evaluation approach for five HIMs. In this summary, specific energy, demand, and net-to-gross approaches will be referenced; however, these approaches will be discussed in detail in Appendices D through I. Table 3-2, provided below, summarizes the overall evaluation approaches and data collection activities.

In general, evaluation activities included examining verified measure counts, energy savings, peak demand reductions, 8760 hourly electric load savings values, and net-to-gross ratios. This section focuses on how energy savings, peak demand savings and net-to-gross ratios were developed for the HIMs covered by the SCCG. The results of the EM&V activities, described below, were used to support the development of operating hours, diversity factors, 8760 hourly impact load shapes, and other key lighting related parameters. These results were developed at a fine level of segmentation (IOU, market segment and space type), such that the segment-level results can be applied to a given participant population to estimate a program-specific estimate for each parameter. These energy savings related results were developed for the upstream and downstream CFLs, linear fluorescents, and high bay lighting

HIMs. For lighting controls (occupancy sensors) and non-HIMs, existing load shape information from the DEER database was used.[1]

In addition, for upstream and downstream CFLs and linear fluorescent measures, baseline information was collected and assessed to develop baseline load shapes and wattages. A pre-retrofit lighting logger study was performed for linear fluorescents to support the development of baseline load shapes, which included spot watt measurements to gather baseline wattage information. Self-report data were gathered for CFL measures to support the development of baseline wattages and load shapes.

Furthermore, in close coordination with the RRCG, a study was performed on upstream CFLs to determine the distribution of measures that were installed in residential versus nonresidential premises (referred to as the residential/nonresidential split assessment). The SCCG conducted thousands of nonresidential telephone surveys and hundreds of on-site visits, and developed an estimate of the number of upstream CFLs that were purchased by the nonresidential population, as described in more detail in Appendix I. The RRCG integrated these results with their analysis of the residential population to determine the fraction of upstream sales made by nonresidential customers. The analysis that produced the final estimate of the fraction of upstream sales to nonresidential customers is reported in the RRCG's Upstream Lighting Evaluation Report, as discussed earlier.

Table 3-2 summarizes the evaluation's level of rigor and a summary of the types of primary data collection activities undertaken.

[1] An attempt was initially made to monitor lighting controls along with other monitored rebated lighting measures, but fewer than expected monitored sites installed lighting controls. Thus, this measure was not included in the lighting logger analysis.

### Table 3-2: Evaluation Rigor Level and Data Collection Activities

| | Rigor Level | | | Data Collection | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Energy** | **kW** | **NTG** | **NTG Surveys** | **Comprehensive Part Surveys** | **Upstream CFL Survey** | **Nonparticipant Surveys** | **Verification On-Sites** | **Metering: TOU loggers** | **Metering: Spot Watt loggers** | **Ex Ante DEER and DEER-Equivalent Values** |
| **HIMs** | | | | | | | | | | | |
| C&I Interior Screw Lighting | | | | | | | | | | | |
| CFL Upstream | E | E | B | | | • | | • | • | | |
| CFL Downstream | E | E | B | | • | | | • | • | | |
| C&I Linear Fluorescent | E | E | E | | • | | • | • | • | • | |
| C&I High Bay Lighting | E | E | E | | • | | • | • | • | • | |
| C&I Lighting Controls | E | E | B | | • | | | | | | • |
| **Non-HIMs** | V | V | B | • | • | | | | | | • |

Rigor Levels: B – Basic E – Enhanced S – Standard V – Verification Only

### *3.2.1 Role of Protocols*

This evaluation was conducted under the rules specified in the CPUC EM&V Protocols.[2] They specify the minimum sample sizes, the required precision, data collection techniques, certain minimum analysis approaches, and formats for documenting and reporting results to the CPUC. This evaluation has endeavored to meet all Protocol requirements.

Four of five HIMs (upstream and downstream CFLs, linear fluorescents and high bay lighting) that are included in the SCCG were assessed at the full impact level of rigor as prescribed by the CPUC EM&V Protocols. Each of these four HIMs relied on end-use monitoring data to support the development of energy savings values. Furthermore, linear fluorescent and high bay measures utilized a billing analysis. An attempt was also made to estimate energy savings for occupancy sensors through a billing analysis, but the results were not statistically significant. For the net-to-gross evaluation, a self-report approach was applied to all five HIMs. Furthermore, a discrete choice analysis was conducted for linear fluorescents and high bay lighting that examined thousands of participant and nonparticipant

2 California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals. Prepared by TecMarket Works for the California Public Utilities Commission. April 2006. p.19-62

surveys regarding lighting purchases made over the past few years. This econometric model was used to estimate the percentage of these lighting purchases that would have been made in the absence of the program, which can be used to estimate a net-to-gross ratio.

For non-HIMs that fall within the key five programs evaluated by the SCCG, the team conducted a verification-guided evaluation for energy and demand savings, relying on the most recent version of DEER or ex ante data. For the net-to-gross evaluation, a self-report approach was utilized, allowing for a basic level of rigor. No on-site data collection activities were conducted for these non-HIM measures; only telephone surveys were used to estimate net-to-gross ratios.

### 3.2.2 Sampling and Data Collection Activities

Evaluation results are based on research conducted with customers and key market actors through primary data collections activities and secondary data collection activities, including phone surveys, on-site visits, end-use monitoring, and the analysis of participant tracking data and utility customer information databases.

There are five types of primary data collection that are used to support various aspects of the evaluation in addition to lighting logger data: TOU and spot watt metering, on-site verification audits, participant telephone interviews, upstream CFL telephone interviews, and nonparticipant telephone interviews. Each of these activities is discussed below and presented in more detail in Appendix G – Lighting Logger Data Analysis.

The sample frame for these activities was based on participant tracking data, and IOU customer information systems (CIS) data for upstream program and nonparticipant samples.

***Lighting Logger and On-Site Activities***

On-site activities served two primary purposes. The first was for measure verification, and the second was for installation of lighting loggers. A first year verification study was conducted that included on-site activities for a large variety of measures, some of which included the HIMs discussed in this report. A separate verification report[3] was developed that documented these activities.

To meet the objectives of this evaluation, an on-site sample was developed with the primary objective being to collect time-of-use data through the installation of lighting loggers to

[3] Report is found at: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/081117_Verification+Report.htm. California Public Utilities Commission. *Energy Efficiency 2006-2007 Verification Report*. Prepared by the Energy Division. 2009.

support the gross energy savings analysis. As part of these on-sites, verification data were also collected. Customers were visited for the lighting logger study and if lighting loggers could not be installed (for various reasons), verification information was still gathered.

*Lighting Logger Sample Design*

The following outlines the sample design for the lighting logger study. A sample design was not specified for the collection of just verification information.

The sample for the time-of-use lighting logger study was designed to meet the objective of estimating the mean lifetime avoided cost savings associated with each of the four HIMs, measured with a high level of confidence. The target level of precision at the IOU portfolio level for each of these four HIMs is as follows: estimate the mean lifetime avoided cost savings with a relative precision of 10% (the margin of error is 10% of the mean) measured at the 90% confidence interval (90/10)[4] for upstream CFLs and linear fluorescent lighting, 90/15 for high bay lighting, and 90/20 for downstream CFLs.

Logger data from the 2003 and 2004-05 Express Efficiency evaluations for CFLs and linear fluorescent fixtures (linear fluorescents were only monitored in 2004-05, with a small sample of high bay fixtures included) were used to help guide the sample design.

Samples by HIM were developed at the IOU and market segment levels for a number of key market segments. The IOU level sample sizes were developed to achieve the overall stated levels of precision mentioned above. The market segment level samples were based on a proportional allocation of the overall sample size, proportional to lifetime avoided cost savings, based on program tracking data. Often times, in order to meet these sample sizes, a census was attempted on the participant population. The resulting preliminary sample design and HIM details are discussed below:

***Linear Fluorescents.*** Based on the analysis of recent Express Efficiency evaluations, for linear fluorescents it was determined that approximately 80 sites at the IOU level would meet this 90/10 precision goal (based on an unweighted distribution of logger data, resulting in a calculated coefficient of variation (CV) of 0.54)[5]. This would require 240 monitored sites across the three IOUs.

---

[4] This ratio (90/10) refers to a 90% confidence interval and 10% relative precision.

[5] The coefficient of variation, or CV, is the standard deviation divided by the mean. A lower CV results in a smaller sample size being needed to achieve a given level of relative precision, as there is less variation relative to the mean.

***High Bay Fixtures.*** The 2004-05 Express Efficiency lighting logger study included a small sample of high bay fixtures. These data indicated that the CV for high bay fixtures was very similar to that of T8s, with a CV of 0.6. A sample size of 50 for each of the three IOUs would meet the 90/15 precision goal set for this measure, totaling 150 sites statewide.

***Upstream CFL.*** Based on the analysis of the 2003-2005 Express logger data, a sample size of approximately 185 sites would be necessary to achieve the 90/10 relative precision goal. This was based on an unweighted CV of 0.83. Unlike linear fluorescents, there was significantly more variation in the CV across the handful of market segment/space types analyzed. Therefore, 555 sites statewide would be required.

***Downstream CFLs.*** As mentioned, the analysis of the 2003-2005 Express logger indicated the average CV for CFLs was 0.83. A sample size of 45 with a CV of 0.83 provides a 90/20 level of precision, for a total statewide sample size of 135.

Based on this approach, 1,080 sites would be required to meet the overall precision goals for these four HIMs. However, this study had a number of secondary objectives that required additional monitoring resources. The first was to develop baseline load shapes for linear fluorescent and high bay fixtures. In order to do this, both pre- and post-retrofit data were planned for monitoring. Additional secondary objectives include estimating mean lifetime avoided cost savings and developing hourly (8,760) load shapes for each HIM, for a number of key market segments, and for a number of space types within each market segment.

In order to meet some of the secondary objectives, some samples sizes were increased beyond what was needed to meet the primary objective, and some pre-retrofit data was collected. For these activities, 1400 monitored sites were initially allocated as follows: 600 sites of post-retrofit monitoring of upstream CFLs, 200 sites of post-retrofit monitoring of downstream CFLs, 250 sites of post-retrofit and 200 sites of pre- and post-retrofit monitoring of linear fluorescents (non high-bay), and 50 sites of post-retrofit and 100 sites of pre- and post-retrofit monitoring of high-bay lighting. All of these samples were greater than that required by the primary sample objective, and would be sufficient to meet the secondary objectives with a reasonable level of precision.

It was initially expected that as many as 50 of the pre-post monitored sites would also include the monitoring of fixtures controlled by occupancy sensors. If this were the case, monitored data could also be used to evaluate the lighting controls HIM. Unfortunately, this was not the case, so this HIM was not evaluated using lighting logger data.

Furthermore, due to difficulties in recruiting customers for the pre-post component of this study, very few high bay participants were monitored, and only 104 linear fluorescent participants were monitored with both pre and post data.

Finally, many of the customers visited on-site for the upstream CFL sample were unable to be monitored for various reasons. In many instances, the lamps installed by the customer were not screw-in CFLs as they claimed during the recruitment phone interview. Therefore, only 446 upstream CFL sites were monitored.

Table 3-3 summarizes the sample sizes designed to meet all of the objectives of the study (both the primary and secondary objectives). Table 3-4 summarizes the achieved sample sizes for the evaluation. The number of sites that were actually monitored and the procedures used to collect and validate this data are discussed below in more detail.

**Table 3-3: Lighting Logger Sample Design**

| HIMs | PG&E | SCE | SDG&E | Total |
|---|---|---|---|---|
| Linear Fluorescents - Post only | 83 | 83 | 83 | 250 |
| Linear Fluorescents - Pre-Post | 66 | 67 | 67 | 200 |
| High Bay - Post only | 17 | 17 | 17 | 50 |
| High Bay - Pre-Post | 34 | 33 | 33 | 100 |
| Upstream CFLs | 200 | 200 | 200 | 600 |
| Downstream CFLs | 80 | 80 | 40 | 200 |
| Occupancy Sensors | 17 | 17 | 17 | 50 |
| **Statewide** | **480** | **480** | **440** | **1,400** |

**Table 3-4: Achieved Sample Sizes**

| HIMs | PG&E | SCE | SDG&E | Total |
|---|---|---|---|---|
| Linear Fluorescents - Post only | 145 | 161 | 133 | 439 |
| Linear Fluorescents - Pre-Post | 35 | 61 | 1 | 97 |
| High Bay - Post only | 26 | 13 | 6 | 45 |
| High Bay - Pre-Post | 2 | - | 2 | 4 |
| Upstream CFLs | 155 | 156 | 140 | 451 |
| Downstream CFLs | 93 | 104 | 37 | 234 |
| Occupancy Sensors | | | | - |
| **Statewide** | **389** | **405** | **287** | **1,081** |

*Logger Data Collection*

The post-retrofit lighting logger sample frame was developed from 2006-2008 program participants that installed linear fluorescents, high bay lighting, and downstream CFLs. Recruitment for these participants was conducted as part of a phone survey; the study was briefly described and respondents were specifically asked if Itron could install lighting loggers at their site. An additional telephone survey was implemented on the nonresidential population to identify recent purchasers of CFLs, and was used as the sample frame for upstream CFL recruitment.

Although the pre-post study was conducted as part of the measurement and verification of the California IOUs' 2006-2008 portfolio of programs, it was not possible to include sites that fell into the 2006-2008 program years because the study commenced at the end of 2008 and required recruitment of sites prior to the actual program participation. Because the participants were recruited during the 2009 bridge funding period and these programs were the same as those implemented in 2006-08, ED and the team concluded that these participants would be representative of the 2006-08 participant population. The programs within the pre-post sample included IOU run rebate and direct install programs, third-party run direct install programs, and local government partnership (LGP) direct install programs. Each program type had unique customer recruitment and project implementation procedures, which required a customized recruitment approach for the pre-post study.

Once on-site, surveyors attempted to log every activity area where rebated lighting measures were installed. Activity areas are defined as areas at the premise that have different activity types (e.g., office, dining room, kitchen) and operating schedules. However, site contacts restricted access to some areas at a few of the sites. Within each activity area, the lamps and fixtures that were logged were selected to fully represent the range of activity types and operation of the rebated measures at each site. Time-of-use lighting loggers were installed at the premise for approximately two months to gather data for the post-only study, one month of post-retrofit data for the pre-post study, and approximately two weeks of pre-retrofit data for the pre-post study. A total of 6,288 loggers were installed in sites for the post-retrofit study, and 919 loggers were installed as part of the pre-post study.

One-time power measurements at the fixture level, referred to as spot watt measurements, were performed primarily for linear fluorescent fixtures and a small number of high bay fixtures. As part of the pre-post study, the field auditors attempted to conduct spot watt measurements for every unique fixture found on site. Most often, this measurement was taken at the fixture for a single ballast-lamp configuration. When fixtures could not be accessed due to height or safety issues, the field auditors took spot measurements of multiple fixtures at the point-of-control (such as the switch) or at the electrical panel. The field auditors recorded volts, power factor, amps, and watts for every measurement, and conducted on-the-spot quality control calculations to ensure the integrity of the measurements.

Spot watt measurements were compared to manufacturer rated ballast model lookup wattages to determine the reliability of the manufacturer's ratings. During the on-site visit, auditors collected information on the manufacturer and model number of the fixtures installed. This information could be used to "look up" the manufacturer's rated wattage for that fixture. For post-retrofit fixtures, spot watt measurements compared well against the manufacturer rated ballast wattages, validating those ratings. However, the manufacturer ratings for the pre-retrofit fixtures were not found to be as accurate. Therefore, for pre-retrofit fixtures, spot watt measurements were used directly to adjust baseline wattages for linear fluorescents.

*Logger Data Validation*

Logger data validation was accomplished with the *viewLoggers* interface, an interactive tool developed by Itron that brought together contextual survey information and logger data information in a single interface, enabling review and quality control disposition. A total of 7,207 loggers were installed, all of which were validated using the *viewLoggers* tool as described in detail in Appendix G.

As a result of the validation process, logger data were marked as either good or unusable. Table 3-5 through Table 3-8 present the number of sites and loggers that were used in the analysis by IOU, building type, and activity area. Tables are shown separately for each HIM. For linear fluorescents, the total number of sites and loggers available are shown for both pre- and post-retrofit data. Because so few high bay pre-post sites were monitored, the pre-post analysis was limited to only linear fluorescent sites. Therefore, only the post-retrofit data were used for the analysis of high bay lighting.

## Table 3-5: All Loggers Installed and Used in Analysis (Linear Fixtures)

| Market Segment / Activity Area | PG&E | | | SCE | | | SDG&E | | | Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sites | Pre-Loggers | Post Loggers | Sites | Pre-Loggers | Post Loggers | Sites | Pre-Loggers | Post Loggers | Sites | Pre-Loggers | Post Loggers |
| **Assembly** | | | | | | | | | | | | |
| Assembly | 2 | - | 4 | 3 | 1 | 16 | 11 | - | 43 | 16 | 1 | 63 |
| HallwayLobby | 2 | - | 4 | 1 | - | 2 | 6 | - | 10 | 9 | - | 16 |
| Kitchen/Break Room | 3 | - | 5 | - | - | - | 7 | - | 14 | 10 | - | 19 |
| Office | 5 | - | 11 | 2 | 7 | 22 | 7 | - | 24 | 14 | 7 | 57 |
| OtherMisc | 9 | 10 | 29 | 4 | 4 | 16 | 9 | - | 33 | 22 | 14 | 78 |
| **Total Assembly** | **9** | **10** | **53** | **6** | **12** | **56** | **11** | **-** | **124** | **26** | **22** | **233** |
| **Grocery** | | | | | | | | | | | | |
| OtherMisc | 3 | 1 | 5 | 4 | 6 | 15 | 2 | - | 8 | 9 | 7 | 28 |
| RetailSales | 5 | 6 | 17 | 9 | 12 | 30 | 2 | - | 8 | 16 | 18 | 55 |
| **Total Grocery** | **5** | **7** | **22** | **9** | **18** | **45** | **2** | **-** | **16** | **16** | **25** | **83** |
| **Health/Medical - Clinic** | | | | | | | | | | | | |
| Comm/Ind Work | 3 | 1 | 5 | 9 | 4 | 17 | 2 | - | 3 | 14 | 5 | 25 |
| HallwayLobby | 8 | 3 | 16 | 21 | 9 | 49 | 3 | - | 17 | 32 | 12 | 82 |
| Kitchen/Break Room | 8 | 2 | 10 | 8 | 4 | 11 | 1 | - | 1 | 17 | 6 | 22 |
| Office | 8 | 15 | 36 | 22 | 9 | 72 | 2 | - | 6 | 32 | 24 | 114 |
| OtherMisc | 6 | - | 24 | 12 | 6 | 22 | 1 | - | 1 | 19 | 6 | 47 |
| Patient Rooms | 2 | 3 | 13 | 8 | - | 16 | 1 | - | 9 | 11 | 3 | 38 |
| Storage | 2 | 1 | 3 | 10 | 4 | 12 | 2 | - | 2 | 14 | 5 | 17 |
| **Total Health/Medical - Clinic** | **12** | **25** | **107** | **25** | **36** | **199** | **3** | **-** | **39** | **40** | **61** | **345** |
| **Office - Small** | | | | | | | | | | | | |
| Comm/Ind Work | 10 | 6 | 19 | 9 | 3 | 15 | 15 | - | 40 | 34 | 9 | 74 |
| Conference Room | 15 | 10 | 25 | 10 | 1 | 16 | 2 | - | 3 | 27 | 11 | 44 |
| HallwayLobby | 22 | 10 | 41 | 21 | 17 | 38 | 18 | - | 38 | 61 | 27 | 117 |
| Kitchen/Break Room | 14 | 5 | 16 | 13 | 3 | 15 | 15 | - | 19 | 42 | 8 | 50 |
| Office | 38 | 46 | 151 | 43 | 51 | 140 | 32 | - | 135 | 113 | 97 | 426 |
| OtherMisc | 6 | 6 | 11 | 6 | 3 | 9 | 4 | - | 9 | 16 | 9 | 29 |
| Restrooms | 6 | 4 | 11 | 4 | 1 | 4 | 5 | - | 6 | 15 | 5 | 21 |
| Storage | 20 | 10 | 27 | 15 | 11 | 30 | 8 | - | 12 | 43 | 21 | 69 |
| **Total Office - Small** | **38** | **97** | **301** | **46** | **90** | **267** | **35** | **-** | **262** | **119** | **187** | **830** |
| **Other** | | | | | | | | | | | | |
| Comm/Ind Work | 10 | 7 | 31 | 16 | 1 | 44 | 7 | - | 26 | 33 | 8 | 101 |
| HallwayLobby | 12 | 1 | 32 | 13 | 3 | 25 | 7 | - | 19 | 32 | 4 | 76 |
| Office | 20 | 9 | 72 | 19 | 5 | 42 | 12 | - | 32 | 51 | 14 | 146 |
| OtherMisc | 20 | 9 | 87 | 24 | 8 | 69 | 7 | - | 24 | 51 | 17 | 180 |
| Restrooms | 4 | - | 7 | 7 | - | 9 | 3 | - | 3 | 14 | - | 19 |
| Storage | 9 | - | 21 | 11 | 1 | 19 | 5 | - | 14 | 25 | 1 | 54 |
| **Total Other** | **36** | **26** | **250** | **36** | **18** | **208** | **16** | **-** | **118** | **88** | **44** | **576** |

## Table 3-5 (cont'd.): All Loggers Installed and Used in Analysis (Linear Fixtures)

| Market Segment | PG&E | | | SCE | | | SDG&E | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity Area | Sites | Pre-Loggers | Post Loggers | Sites | Pre-Loggers | Post Loggers | Sites | Pre-Loggers | Post Loggers | Sites | Pre-Loggers | Post Loggers |
| **Restaurant** | | | | | | | | | | | | |
| Dining | 3 | 1 | 7 | 6 | 1 | 12 | 4 | - | 8 | 13 | 2 | 27 |
| Kitchen/Break Room | 8 | 15 | 16 | 10 | 6 | 14 | 3 | - | 6 | 21 | 21 | 36 |
| OtherMisc | 6 | 10 | 8 | 5 | 9 | 9 | 2 | - | 6 | 13 | 19 | 23 |
| **Total Restaurant** | **10** | **26** | **31** | **10** | **16** | **35** | **6** | **-** | **20** | **26** | **42** | **86** |
| **Retail - Small** | | | | | | | | | | | | |
| Auto Repair Workshop | 17 | 24 | 52 | 14 | 12 | 24 | 7 | - | 18 | 38 | 36 | 94 |
| Comm/Ind Work | 12 | 7 | 23 | 16 | 11 | 30 | 11 | - | 25 | 39 | 18 | 78 |
| HallwayLobby | 12 | 2 | 16 | 16 | 9 | 22 | 11 | - | 23 | 39 | 11 | 61 |
| Kitchen/Break Room | 10 | 3 | 10 | 13 | 5 | 18 | 5 | - | 6 | 28 | 8 | 34 |
| Office | 37 | 12 | 79 | 29 | 35 | 60 | 21 | - | 43 | 87 | 47 | 182 |
| OtherMisc | 9 | 2 | 9 | 20 | 21 | 22 | 3 | - | 6 | 32 | 23 | 37 |
| Restrooms | 10 | 2 | 14 | 10 | 6 | 9 | 3 | - | 3 | 23 | 8 | 26 |
| RetailSales | 41 | 12 | 121 | 46 | 35 | 130 | 31 | - | 119 | 118 | 47 | 370 |
| Storage | 24 | 5 | 43 | 36 | 18 | 64 | 18 | - | 32 | 78 | 23 | 139 |
| **Total Retail - Small** | **67** | **69** | **367** | **84** | **152** | **379** | **48** | **-** | **275** | **199** | **221** | **1,021** |
| **Warehouse** | | | | | | | | | | | | |
| Office | 6 | 3 | 18 | 11 | 36 | 62 | 9 | - | 46 | 26 | 39 | 126 |
| OtherMisc | 5 | 11 | 23 | 11 | 15 | 24 | 8 | - | 26 | 24 | 26 | 73 |
| Storage | 4 | - | 11 | 12 | 18 | 40 | 9 | 12 | 26 | 25 | 30 | 77 |
| **Total Warehouse** | **8** | **14** | **52** | **16** | **69** | **126** | **16** | **12** | **98** | **40** | **95** | **276** |
| **TOTAL** | **370** | **548** | **2,366** | **464** | **822** | **2,630** | **274** | **24** | **1,904** | **554** | **697** | **3,450** |

## Table 3-6: All Loggers Installed and Used in Analysis (High Bay Fixtures)

| Market Segment | PG&E | | SCE | | SDG&E | | Total | |
|---|---|---|---|---|---|---|---|---|
| Activity Area | Sites | Loggers | Sites | Loggers | Sites | Loggers | Sites | Loggers |
| **Other** | | | | | | | | |
| Comm/Ind Work | 16 | 55 | 7 | 22 | 6 | 15 | 29 | 92 |
| OtherMisc | 5 | 11 | 2 | 4 | 1 | 2 | 8 | 17 |
| Storage | 9 | 37 | 4 | 15 | 0 | 0 | 13 | 52 |
| **Total Other** | **26** | **103** | **13** | **41** | **6** | **17** | **45** | **161** |

## Table 3-7: All Loggers Installed and Used in Analysis (Downstream CFLs)

| Market Segment / Activity Area | PG&E Sites | PG&E Loggers | SCE Sites | SCE Loggers | SDG&E Sites | SDG&E Loggers | Total Sites | Total Loggers |
|---|---|---|---|---|---|---|---|---|
| **Assembly** | | | | | | | | |
| Assembly | 2 | 7 | 4 | 18 | 3 | 4 | 9 | 29 |
| HallwayLobby | 4 | 6 | 5 | 11 | 4 | 7 | 13 | 24 |
| OtherMisc | 4 | 11 | 5 | 13 | 5 | 10 | 14 | 34 |
| Restrooms | 3 | 5 | 2 | 2 | 4 | 7 | 9 | 14 |
| **Total Assembly** | **6** | **29** | **7** | **44** | **9** | **28** | **22** | **101** |
| **Health/Medical - Clinic** | | | | | | | | |
| HallwayLobby | 4 | 15 | 6 | 7 | 1 | 2 | 11 | 24 |
| OtherMisc | 3 | 24 | 4 | 7 | 1 | 2 | 8 | 33 |
| Restrooms | 2 | 3 | 7 | 14 | 0 | 0 | 9 | 17 |
| **Total Health/Medical - Clinic** | **6** | **42** | **12** | **28** | **1** | **4** | **19** | **74** |
| **Lodging** | | | | | | | | |
| Guest Rooms | 17 | 156 | 3 | 24 | 2 | 34 | 22 | 214 |
| OtherMisc | 11 | 39 | 1 | 10 | 1 | 3 | 13 | 52 |
| **Total Lodging** | **20** | **195** | **3** | **34** | **3** | **37** | **26** | **266** |
| **Office - Small** | | | | | | | | |
| OtherMisc | 7 | 11 | 6 | 8 | 0 | 0 | 13 | 19 |
| Restrooms | 9 | 15 | 23 | 23 | 5 | 6 | 37 | 44 |
| **Total Office - Small** | **12** | **26** | **24** | **31** | **5** | **6** | **41** | **63** |
| **Other** | | | | | | | | |
| OtherMisc | 7 | 15 | 6 | 8 | 1 | 1 | 14 | 24 |
| Restrooms | 5 | 9 | 11 | 15 | 5 | 7 | 21 | 31 |
| Storage | 3 | 3 | 6 | 7 | 0 | 0 | 9 | 10 |
| **Total Other** | **12** | **27** | **16** | **30** | **6** | **8** | **34** | **65** |
| **Restaurant** | | | | | | | | |
| OtherMisc | 3 | 15 | 2 | 5 | 1 | 1 | 6 | 21 |
| Restrooms | 3 | 4 | 3 | 4 | 1 | 1 | 7 | 9 |
| **Total Restaurant** | **4** | **19** | **3** | **9** | **2** | **2** | **9** | **30** |
| **Retail - Large** | | | | | | | | |
| RetailSales | 4 | 11 | 4 | 9 | 0 | 0 | 8 | 20 |
| **Total Retail - Large** | **4** | **11** | **4** | **9** | **0** | **0** | **8** | **20** |
| **Retail - Small** | | | | | | | | |
| OtherMisc | 4 | 5 | 7 | 11 | 1 | 2 | 12 | 18 |
| Restrooms | 20 | 26 | 28 | 35 | 10 | 12 | 58 | 73 |
| RetailSales | 7 | 10 | 5 | 7 | 1 | 2 | 13 | 19 |
| Storage | 7 | 9 | 6 | 9 | 1 | 2 | 14 | 20 |
| **Total Retail - Small** | **29** | **50** | **35** | **62** | **11** | **18** | **75** | **130** |
| **TOTAL** | **93** | **399** | **104** | **247** | **37** | **103** | **234** | **749** |

## Table 3-8: All Loggers Installed and Used in Analysis (Upstream CFL)

| Market Segment | PG&E | | SCE | | SDG&E | | Total | |
|---|---|---|---|---|---|---|---|---|
| Activity Area | Sites | Loggers | Sites | Loggers | Sites | Loggers | Sites | Loggers |
| **Assembly** | | | | | | | | |
| Assembly | 9 | 23 | 6 | 20 | 4 | 12 | 19 | 55 |
| HallwayLobby | 12 | 23 | 16 | 46 | 4 | 6 | 32 | 75 |
| Kitchen/BreakRoom | 2 | 3 | 5 | 6 | 1 | 1 | 8 | 10 |
| Office | 3 | 10 | 9 | 13 | 1 | 3 | 13 | 26 |
| OtherMisc | 6 | 17 | 13 | 37 | 3 | 7 | 22 | 61 |
| Outdoor | 2 | 5 | 1 | 1 | 2 | 3 | 5 | 9 |
| Restrooms | 8 | 15 | 13 | 19 | 6 | 9 | 27 | 43 |
| Storage | 8 | 11 | 9 | 12 | 2 | 2 | 19 | 25 |
| **Total Assembly** | **22** | **107** | **26** | **154** | **13** | **43** | **61** | **304** |
| **Health/Medical - Clinic** | | | | | | | | |
| HallwayLobby | 1 | 2 | 6 | 15 | 11 | 18 | 18 | 35 |
| Office | 3 | 8 | 3 | 5 | 7 | 13 | 13 | 26 |
| OtherMisc | 1 | 1 | 5 | 14 | 5 | 7 | 11 | 22 |
| Restrooms | - | - | 4 | 6 | 5 | 9 | 9 | 15 |
| **Total Health/Medical - Clinic** | **4** | **11** | **8** | **40** | **16** | **47** | **28** | **98** |
| **Lodging** | | | | | | | | |
| GuestRooms | 29 | 140 | 33 | 150 | 7 | 78 | 69 | 368 |
| HallwayLobby | 15 | 30 | 22 | 52 | 10 | 21 | 47 | 103 |
| Kitchen/BreakRoom | 2 | 3 | 4 | 5 | 2 | 4 | 8 | 12 |
| Mechanical/ElectricalRoom | 5 | 7 | 7 | 8 | 2 | 3 | 14 | 18 |
| Office | - | - | 7 | 10 | 3 | 3 | 10 | 13 |
| OtherMisc | 6 | 13 | 7 | 12 | 1 | 4 | 14 | 29 |
| Outdoor | 1 | 1 | 3 | 5 | - | - | 4 | 6 |
| Restrooms | 12 | 24 | 12 | 19 | 7 | 10 | 31 | 53 |
| Storage | 2 | 4 | 7 | 8 | 2 | 3 | 11 | 15 |
| **Total Lodging** | **31** | **222** | **37** | **269** | **11** | **126** | **79** | **617** |
| **Office - Small** | | | | | | | | |
| HallwayLobby | 12 | 29 | 12 | 26 | 9 | 16 | 33 | 71 |
| Office | 7 | 12 | 6 | 8 | 12 | 22 | 25 | 42 |
| OtherMisc | 7 | 10 | 3 | 8 | 4 | 8 | 14 | 26 |
| Outdoor | 1 | 3 | 3 | 6 | - | - | 4 | 9 |
| Restrooms | 4 | 4 | 8 | 11 | 13 | 21 | 25 | 36 |
| Storage | 8 | 10 | - | - | 4 | 5 | 12 | 15 |
| **Total Office - Small** | **17** | **68** | **20** | **59** | **28** | **72** | **65** | **199** |
| **Other** | | | | | | | | |
| HallwayLobby | 8 | 13 | 5 | 12 | 5 | 16 | 18 | 41 |
| Office | 7 | 8 | 1 | 1 | 2 | 4 | 10 | 13 |
| OtherMisc | 7 | 12 | 6 | 14 | 4 | 14 | 17 | 40 |
| Outdoor | 2 | 3 | - | - | - | - | 2 | 3 |
| Restrooms | 9 | 14 | 11 | 27 | 8 | 17 | 28 | 58 |
| Storage | 11 | 16 | 4 | 14 | 1 | 4 | 16 | 34 |
| **Total Other** | **21** | **66** | **17** | **68** | **13** | **55** | **51** | **189** |

## Table 3-8 (cont'd.): All Loggers Installed and Used in Analysis (Upstream CFL)

| Market Segment | PG&E | | SCE | | SDG&E | | Total | |
|---|---|---|---|---|---|---|---|---|
| Activity Area | Sites | Loggers | Sites | Loggers | Sites | Loggers | Sites | Loggers |
| **Restaurant** | | | | | | | | |
| Dining | 12 | 23 | 21 | 53 | 16 | 35 | 49 | 111 |
| HallwayLobby | 10 | 19 | 11 | 19 | 4 | 4 | 25 | 42 |
| Kitchen/BreakRoom | 4 | 4 | 11 | 13 | 2 | 2 | 17 | 19 |
| Office | 5 | 6 | 5 | 6 | 2 | 2 | 12 | 14 |
| OtherMisc | 2 | 2 | - | - | 1 | 2 | 3 | 4 |
| Outdoor | 1 | 1 | 1 | 1 | - | - | 2 | 2 |
| Restrooms | 17 | 28 | 14 | 21 | 5 | 6 | 36 | 55 |
| Storage | 13 | 29 | 8 | 13 | 6 | 8 | 27 | 50 |
| **Total Restaurant** | **30** | **112** | **26** | **126** | **21** | **59** | **77** | **297** |
| **Retail - Small** | | | | | | | | |
| HallwayLobby | 3 | 4 | 3 | 4 | 8 | 13 | 14 | 21 |
| Office | 5 | 9 | 5 | 7 | 4 | 5 | 14 | 21 |
| OtherMisc | 4 | 6 | 3 | 4 | 6 | 7 | 13 | 17 |
| Outdoor | 1 | 2 | - | - | - | - | 1 | 2 |
| Restrooms | 13 | 16 | 9 | 18 | 13 | 19 | 35 | 53 |
| RetailSales | 15 | 35 | 11 | 26 | 18 | 35 | 44 | 96 |
| Storage | 9 | 13 | 5 | 10 | 2 | 2 | 16 | 25 |
| **Total Retail - Small** | **30** | **85** | **22** | **69** | **38** | **81** | **90** | **235** |
| **TOTAL** | **155** | **671** | **156** | **785** | **140** | **483** | **451** | **1,939** |

*On-Site Verification Audits*

In addition to installing lighting loggers, the on-sites collected data to support a number of other research objectives. Verification data were collected to support installation rates as well as storage rates for CFLs. Equipment manufacturer and model numbers were collected in order to perform lookups that would support the estimate of pre- and post-retrofit wattages. Self-report data were gathered on the configuration and wattage of pre-retrofit equipment to help support the estimate of pre-retrofit wattages. Finally, self-report data were gathered on lighting equipment usage schedules to aid in the development of pre-retrofit load shapes

Table 3-9 through Table 3-12 present the number of on-sites conducted for each HIM by IOU and market segment that provided data either for the lighting logger study or verification analysis. Note that not all on-site surveys included logger installations. For sites where loggers were not installed for an assortment of reasons, the equipment was still verified (downstream) or inventoried (upstream CFLs) and these sites are referred to as "verified-only" sites.

### Table 3-9: Number of On-Sites Conducted by IOU and Market Segment (Upstream CFL)

| Market Segment | PG&E Sites | SCE Sites | SDG&E Sites | Total |
|---|---|---|---|---|
| Agriculture | 4 | | 2 | **6** |
| All Commercial | 7 | 3 | 4 | **14** |
| Assembly | 23 | 27 | 18 | **68** |
| Education - Primary School | 3 | 3 | 3 | **9** |
| Government | 1 | 5 | | **6** |
| Grocery | | | 1 | **1** |
| Health/Medical – Clinic | 4 | 11 | 17 | **32** |
| Health/Medical – Hospital | | | 1 | **1** |
| Lodging | 34 | 39 | 13 | **86** |
| Office – Large | 3 | 3 | 5 | **11** |
| Office – Small | 22 | 24 | 34 | **80** |
| Other Industrial | 6 | 3 | 2 | **11** |
| Residential Multifamily | | 3 | | **3** |
| Restaurant - Fast Food | 3 | 10 | 8 | **21** |
| Restaurant - Sit Down | 29 | 24 | 22 | **75** |
| Retail – Large | | | 3 | **3** |
| Retail – Small | 33 | 24 | 56 | **113** |
| Utilities | | | | **0** |
| Warehouse | 2 | 6 | 2 | **10** |
| **TOTAL** | **174** | **188** | **191** | **553** |

### Table 3-10: Number of On-Sites Conducted by IOU and Market Segment (Downstream CFL)

| Market Segment | PG&E Sites | SCE Sites | SDG&E Sites | Total |
|---|---|---|---|---|
| Agriculture | 3 | | | **3** |
| All Commercial | 1 | 6 | | **7** |
| Assembly | 8 | 7 | 12 | **27** |
| Education - Primary School | 1 | 6 | | **7** |
| Government | 2 | | | **2** |
| Grocery | 2 | 5 | | **7** |
| Health/Medical – Clinic | 9 | 20 | 1 | **30** |
| Health/Medical - Hospital | 1 | | | **1** |
| Home Depot | 6 | 6 | | **12** |
| Lodging | 24 | 3 | 3 | **30** |
| Office – Large | 1 | | | **1** |
| Office – Small | 16 | 30 | 6 | **52** |
| Other Industrial | 3 | 3 | 6 | **12** |
| Residential Multifamily | 1 | 1 | | **2** |
| Restaurant - Fast Food | 3 | | 1 | **4** |
| Restaurant - Sit Down | 3 | 6 | 1 | **10** |
| Retail – Large | 1 | | | **1** |
| Retail – Small | 36 | 46 | 16 | **98** |
| Utilities | 1 | | | **1** |
| Warehouse | 1 | 3 | 5 | **9** |
| **TOTAL** | **123** | **142** | **51** | **316** |

**Table 3-11: Number of On-Sites Conducted by IOU and Market Segment (Linear Fixtures)**

| Market Segment | PG&E Sites | SCE Sites | SDG&E Sites | Total |
|---|---|---|---|---|
| Agriculture | 2 | | | **2** |
| All Commercial | 5 | 13 | 11 | **29** |
| Assembly | 9 | 5 | 19 | **33** |
| Education - Primary School | 3 | 5 | 2 | **10** |
| Government | 6 | 1 | | **7** |
| Grocery | 4 | 5 | 2 | **11** |
| Health/Medical – Clinic | 9 | 21 | 6 | **36** |
| Health/Medical - Hospital | 1 | | | **1** |
| Lodging | 10 | 1 | 1 | **12** |
| Office – Large | 4 | | 1 | **5** |
| Office – Small | 28 | 38 | 50 | **116** |
| Other Industrial | 5 | 16 | 22 | **43** |
| Residential Multifamily | 1 | 1 | | **2** |
| Restaurant - Fast Food | 3 | 1 | 7 | **11** |
| Restaurant - Sit Down | 2 | 7 | 1 | **10** |
| Retail – Large | | | | **0** |
| Retail – Small | 57 | 58 | 84 | **199** |
| Utilities | 1 | | | **1** |
| Warehouse | 8 | 11 | 18 | **37** |
| **TOTAL** | **158** | **183** | **224** | **565** |

**Table 3-12: Number of On-sites Conducted by IOU and Market Segment (High Bay)**

| Market Segment | PG&E Sites | SCE Sites | SDG&E Sites | Total |
|---|---|---|---|---|
| Agriculture | 1 | 1 | | **2** |
| All Commercial | 2 | 2 | 2 | **6** |
| Assembly | 4 | 1 | 2 | **7** |
| Education - Primary School | 1 | 1 | | **2** |
| Government | 1 | | | **1** |
| Grocery | | | | **0** |
| Health/Medical – Clinic | | | | **0** |
| Health/Medical - Hospital | | | | **0** |
| Lodging | | | | **0** |
| Office - Large | | | | **0** |
| Office - Small | 1 | | 1 | **2** |
| Other Industrial | 7 | 8 | 12 | **27** |
| Residential Multifamily | | | | **0** |
| Restaurant - Fast Food | | | | **0** |
| Restaurant - Sit Down | | | | **0** |
| Retail - Large | 1 | | | **1** |
| Retail - Small | 6 | 3 | 8 | **17** |
| Utilities | | | | **0** |
| Warehouse | 15 | 7 | 11 | **33** |
| **TOTAL** | **39** | **23** | **36** | **98** |

## ***Telephone Survey Activities***

Three types of survey activities were conducted: participant telephone surveys, upstream CFL telephone surveys, and nonparticipant telephone surveys. The telephone survey instruments used for these three efforts are provided in Appendix A. These activities are discussed below.

### *Sample Design*

Participant surveys gathered data to:

- Determine program free ridership (NTG),
- Recruit participants for on-site inspections and the lighting logger study,
- Support the discrete choice analysis for linear fluorescent and high bay measures, and
- Support the billing analysis for linear fluorescent and high bay measures.

The initial sample designs were developed at the program and measure level as part of the SCCG Evaluation Plan dated July 11, 2008. For the five HIMs receiving a full impact evaluation, minimum sample sizes were developed either to meet the needs of the NTGR analysis or to support the billing and discrete choice analysis. These sample designs were developed at the program (and HIM) level and were set at 300, 150, 65, or an expected census. A sample size of 300 was selected to support the billing and discrete choice analysis for linear fluorescents (in one instance 500 was specified for program SDGE3020 as this measure contributed over a quarter of the program's savings).

Sample sizes of 300 were also selected for measures that had significant contributions to savings such that reliable net-to-gross results could be achieved, and could meet the protocol requirement for the basic level of rigor.

For HIMs and non-HIMs that were not major contributors to a program, or where the savings were relatively small at the portfolio level, sample sizes of 150 or 65 were selected. The values of 150 and 65 will provide self-report NTG ratios with levels of precision at 90/10 and 90/15, respectively (assuming a binomial distribution with a mean net-to-gross ratio of 65%).

However, participant surveys were also used to recruit customers for the lighting logger study. In most cases, the number of customers to be recruited would require more customers to be surveyed than was originally planned as discussed above. Therefore, in many instances the resulting sample sizes were driven by the need to recruit customers for the lighting logger study and, in some cases, a census was attempted.

The nonparticipant survey was designed to support the discrete choice analysis. The sample size of 1,000 was selected based on past experience with conducting discrete choice analysis and the need to ensure that a sufficient sample of non-program adopters were found for the linear fluorescents and high bay fixtures. This sample was supplemented by 2,939 additional nonparticipant surveys recently conducted for the 2004-05 Express Efficiency evaluation.

The primary objective of the upstream CFL survey was to estimate the number of upstream CFLs installed in nonresidential facilities. This survey was also used to recruit customers for the lighting logger study. To develop this sample frame, the IOUs' CIS (Customer Information System) data were used. The team developed an initial sample size of 1,500, believing this to be a minimum number necessary to recruit the 600 customers for the lighting logger study.

*Survey Data Collection*

*Participant telephone survey* instruments were developed to collect data to support various aspects of the overall evaluation. The survey questionnaire contained questions to gather information about customer and facility characteristics, verification of the number and type of program measures installed, changes in the number and type of measures not rebated through the program, knowledge of energy efficient equipment, awareness of energy efficiency programs, and questions to support self-report and discrete choice net-to-gross analyses. Participants were also asked about the age, type, and condition of their lighting measures and other types of equipment in their business to support the billing analysis. The participant survey was also used to recruit customers for the lighting logger study.

In total, 3,574 participant telephone interviews were conducted for the above purposes. Table 3-13 shows the distribution of completed surveys by IOU and measure conducted with participating customers.

**Table 3-13: Number of Participant Surveys by IOU and Measure**

| | Linear Fluorescent | High Bay | Downstream CFL | Occupancy Sensor | Non-HIMs | Total* |
|---|---|---|---|---|---|---|
| PG&E | 511 | 224 | 307 | 59 | 151 | 977 |
| SCE | 1,147 | 59 | 784 | 0 | 73 | 1,296 |
| SCG | 0 | 0 | 0 | 0 | 67 | 67 |
| SDG&E | 1,050 | 119 | 59 | 63 | 47 | 1,234 |
| **Statewide** | **2,708** | **402** | **1,150** | **122** | **338** | **3,574** |

* Totals are the number of unique sites. Because multiple measures may be installed at the same site, the sum of sites across measures may be greater than the total.

Table 3-14 and Table 3-15 compare the initial participant survey sample design and the actual number of surveys that were completed by program and measure.

**Table 3-14: Participant Survey Sample Design**

| | Linear Fluorescent | High Bay | Downstream CFL | Occupancy Sensor | Non-HIMs | Total* |
|---|---|---|---|---|---|---|
| PGE2080 | 300 | | 300 | 150 | 150 | 900 |
| PGE other | | | | | | 0 |
| SCE2511 | 300 | | 300 | | 65 | 665 |
| SCE2517 | | | | | | 0 |
| SCG3507 | | | | | 150 | |
| SDGE3012 | 300 | | 65 | 65 | 65 | 495 |
| SDGE3020 | 500 | | 65 | | 65 | 630 |
| **Statewide** | **1400** | **0** | **730** | **215** | **495** | **2840** |

* Totals are the number of unique sites. Because multiple measures may be installed at the same site, the sum of sites across measures may be greater than the total.

**Table 3-15: Participant Surveys Sample by Program**

| | Linear Fluorescent | High Bay | Downstream CFL | Occupancy Sensor | Non-HIMs | Total* |
|---|---|---|---|---|---|---|
| PGE2080 | 309 | 224 | 102 | 59 | 151 | 732 |
| PGE other | 212 | 0 | 212 | 0 | 0 | 262 |
| SCE2511 | 1,000 | 0 | 742 | 0 | 65 | 1,070 |
| SCE2517 | 147 | 59 | 43 | 0 | 0 | 220 |
| SCG3507 | 0 | 0 | 0 | 0 | 75 | 75 |
| SDGE3012 | 32 | 28 | 9 | 22 | 18 | 96 |
| SDGE3020 | 1,019 | 91 | 167 | 41 | 29 | 1,141 |
| **Statewide** | **2,708** | **402** | **1,150** | **122** | **338** | **3,574** |

* Totals are the number of unique sites. Because multiple measures may be installed at the same site, the sum of sites across measures may be greater than the total.

*Nonparticipant Telephone Interviews.* Additional nonparticipant telephone interviews were collected to support the discrete choice analysis for linear fluorescent and high bay fixtures. A total of 1,039 statewide nonparticipants were interviewed for this purpose. Table 3-16 presents the number of nonparticipant surveys conducted in each of the IOUs' service territories.

**Table 3-16: Nonparticipant Survey Completes by IOU**

| Utility | | Total Surveys |
|---|---|---|
| PG&E | | 348 |
| SCE | | 353 |
| SDG&E | | 338 |
| | **Statewide** | **1,039** |

*Upstream CFL Telephone Interviews.* Upstream CFL participants are not tracked; thus the program tracking database does not contain the information necessary to identify the location of the measure installed. Therefore, a general nonresidential population survey was conducted to identify CFL purchasers to support the net-to-gross analysis for upstream CFLs, support the residential/nonresidential upstream CFL split analysis, and recruit customers for the lighting logger study.[6] As shown in Table 3-17, 8,362 customers were surveyed and 1,533 were identified as having purchased through retail channels.

**Table 3-17: Upstream CFL Surveys by IOU**

| | | Total Surveys | CFL Purchasers |
|---|---|---|---|
| PG&E | | 2,434 | 586 |
| SCE | | 2,533 | 426 |
| SDG&E | | 3,395 | 521 |
| | **Statewide** | **8,362** | **1,533** |

## ***Secondary Data Sources***

Several secondary data sources were utilized for this evaluation, as described below.

*Participant Tracking Data*

The SCCG utilized each IOU's program tracking database to assemble summary statistics on participation for the period 2006-2008.

*IOU Work Papers*

The IOUs' work papers, which document the per unit savings values for each of their measures, were reviewed for the HIMs.

6 Please note that these survey efforts were conducted solely by the SCCG. Additional survey efforts were conducted by the RRCG to further support the net-to-gross analysis for upstream CFLs and the residential/nonresidential upstream CFL split analysis.

*IOU Quarterly Reports/E3 Tables*

The team reviewed monthly and quarterly reports and E3 tables for IOU-claimed impact/participation savings.

*DEER Database*

The Database for Energy Efficient Resources (DEER) was a very important data source that provided information on key parameters for non-HIM measures.

*CIS Customer and Billing Data*

CIS data were used to pull sample for the nonparticipant and upstream CFL survey. The billing analysis, which covered the period 2005 (parts of 2004 for some IOUs) through June 2009, was supported by CIS billing data.

### 3.2.3 Gross Impact Analysis Approach

There are three basic approaches implemented for the gross energy assessment: load data analysis utilizing lighting logger data, billing analysis, and the application of DEER or ex ante estimates.

***Lighting Load Data Analysis***

This approach was applied to the linear fluorescent, high bay lighting, upstream CFL, and downstream CFL HIMs. As mentioned earlier, a sample design for monitoring activities was developed such that load shapes can be reliably estimated for a number of key market segments, and space types within those market segments. Using these segment level load shapes, segment level results were weighted to any given participant population in order to develop an overall load shape for that population. Both baseline and post-retrofit load shapes are developed and an impact is derived by taking the difference between the two load shapes. Annual savings is simply the aggregation of the impact load shapes over the year.

For any given hour, the load impact is estimated as:

$$\begin{aligned} Impact\_Hour\_i = & (Pre\_Wattage \times Percent\_On\_Pre\_Hour\_i) \\ & -(Post\_Wattage \times Percent\_On\_Post\_Hour\_i) \end{aligned}$$

The following steps were taken to estimate each individual parameter that comprises this calculation.

- The first step is to develop 8760 hourly load shapes of the percentage of the hour that the lights are on for post-retrofit equipment, by IOU, program, and market segment, utilizing the post-retrofit monitoring data.
- The second step is to develop baseline or pre-period 8760 hourly load shapes of the percentage of the hour that the lights are on, by IOU program and market segment. Pre- and post-retrofit monitoring data and self-report data indicated that there was not a statistically significant difference between the pre- and post-retrofit annual usage, so the pre-retrofit load shape was set equal to the post-retrofit load shape.
- The third step is to develop the average pre- and post-retrofit wattages by program and measure. Wattages for linear fluorescent and high bay lighting were based on a combination of spot watt measurements and manufacturer data. For CFLs, wattages were based on manufacturer data and self-report data.
- The fourth step is to apply the pre- and post-retrofit wattages (by program and measure) to the pre- and post-retrofit percent-on load shapes (by program and market segment), respectively. This results in pre- and post-retrofit kW load shapes by program, market segment, and measure.
- An impact load shape can now be developed for each program, market segment, and measure by simply subtracting the pre and post load shapes. Finally, aggregating these load shapes up over the 8760 hours provides an estimate of the unit energy savings.

Interactive effects were not considered in this evaluation. Further analysis will be conducted to apply factors for interactive effects based on the evaluation results and the method and results will be presented in the Energy Division report.

## 3.3 Billing Analysis Methodology

The objective of the billing analysis is to determine the first-year energy impacts from the installation of T8s and T5s, delamping, and high bay T8 and T5 measures under the 2006-2008 IOU programs. The billing analysis uses a statistically adjusted engineering (SAE) model to estimate the gross realization rate of these measures. The analysis also develops realization rates for other lighting and electricity savings measures installed under the energy efficiency programs, though this was not the focus of the analysis.

The SAE models are estimated separately by utility to determine the observable savings from each utility's linear fluorescent program. The model uses customer billing data, independent variables gathered during the telephone survey, customer-tracking data, and energy impacts associated with measures installed under the programs. Examination of the utility billing data and the measure installation data led the team to further divide the sample by delivery mechanism, estimating separate models for PG&E direct install and prescriptive rebate programs, SCE direct install and prescriptive rebate programs, and SDG&E direct install.[7,8]

The models were designed to explain the monthly energy usage as a function of usage for the previous12 months, changes in weather, the engineering ex post savings associated with the installation of rebated linear fluorescent measures, the ex ante savings associated with the installation of other rebated lighting and non-lighting measures, the installation of measures outside a utility program, and other changes at the site.

The generalized linear fluorescent model specification is written as:

$$kWh_{it} = \beta_0 + \beta_1 kWh_{it-12} + \beta_2 LinearLTSav_{it} + \beta_5 OthLTSav_{it} + \beta_6 OthSav_{it} + \beta_5 X_{it} + \varepsilon_{it}$$

where the following definitions apply:[9]

| | | |
|---|---|---|
| $kWh_{it}$ | = | The monthly electricity consumption for site *i* in month *t* |
| $kWh_{it-12}$ | = | monthly electricity consumption for site *i* in month *t-12* |
| $LinearLTSav_{it}$ | = | an engineering ex post estimate of the monthly lighting savings at site *i* in month *t* due to the installation of linear fluorescent |
| $OthLTSav_{it}$ | = | an engineering ex ante estimate of the monthly lighting savings at site *i* in month *t* due to the installation of non-linear high efficiency lighting measures |
| $OthSav_{it}$ | = | an engineering ex ante estimate of the monthly savings at site *i* in month *t* due to the installation of non-lighting energy efficiency measures |
| $X_{it}$ | = | a vector of site specific variable to control for site specific changes at site *i* in month t |

The specifications of the SAE model varied by utility and delivery mechanism. All models, however, incorporated the lighting logger and pre-post wattage updates to the ex ante savings estimates for linear fluorescent lighting measures or the engineering ex post savings. All other lighting and non-lighting energy efficiency measure savings included

7 See Appendix H for a more substantial description of the analysis data sets.

8 The analysis data set for SDG&E prescriptive rebate included only 43 sites. The size of the sample was insufficient to estimate an SAE model.

9 A more disaggregated model specification is provided in Appendix H.

in the model use the utility ex ante estimates of savings. By using the updated engineering estimates of savings for the linear fluorescent lighting measures, the team is incorporating into the analysis the most up to date estimate of savings. Following the estimation of the statistical realization rates, the final ex post savings estimates for linear fluorescent lighting measures will be calculated by applying the SAE coefficients to the engineering ex post savings estimate calculated in the lighting logger and pre-post wattage analysis.

### *3.3.1 Gross Peak Demand (kW) Assessment*

There are two basic approaches that will be implemented for the gross demand assessment: load data analysis and the application of DEER.

Section 3.2.3 above presents the load data analysis that will be used for linear fluorescents, high bay lighting, upstream CFLs and downstream CFLs. Peak demand impacts can be directly estimated using these impact load shapes. DEER will be used for all other measures.

### *3.3.2 Net Savings Analysis Approach*

The approach relies on self-report methods for all HIMs, as well as a discrete choice analysis for linear fluorescent and high bay lighting. The approach for upstream CFLs will rely on interviews with retailers and manufacturers. This analysis was conducted by the RRCG and is presented in that group's report.

***Self-Report Approach***

One objective of the California energy efficiency program evaluations is to identify the portion of savings directly attributable to the Program effort, and to properly account for those effects that would have occurred in the absence of the program. California reporting protocols for the 2006-2008 program require the discounting of savings by a "free-ridership factor" in the estimation of net program savings by applying this net-to-gross ratio (NTGR). The 2006 Evaluation Protocols allow for the use of a participant self-report approach (SRA) to estimate the net-to-gross ratio for the basic level of rigor and with additional participant-specific documentation for the standard level of rigor.

The Energy Division convened a committee of evaluators to develop a standard framework for the measurement of net-to-gross ratios for residential and small commercial programs in a systematic and consistent manner using the SRA approach. The approach was designed to fully comply with the Evaluation Protocols. With the assistance of its technical consultants and evaluators, the Energy Division developed the *Guidelines for Estimating Net-To-Gross*

*Ratios Using the Self-Report Approaches*,[10] which provided more detailed guidance than was available in the California Evaluation Protocols.[11] These guidelines can be found in Appendix D.

Individuals who were involved in the decision-making process at each participating household or small commercial site were interviewed to measure the program's influence on respondents' decision-making. The survey obtained highly structured responses concerning the probability that the household or firm would have installed the same measure(s) at the same time in the absence of the program. The survey also included open-ended and closed-ended questions that focused on the household's or firm's motivation for installing the efficiency measure. These questions covered all the requirements provided in the Guidelines, such as multiple questions; efficiency level; likelihood of adoption; timing and quantity; and consistency checks.

The NTGR algorithm derived four separate measurements of free ridership from different inquiry routes. The first measurement consisted of responses to a series of yes/no questions that measured the impact of the program on the quantity, efficiency, and timing of the purchase. The second measurement consisted of a 0-10 scale that asked the likelihood that the respondent would have purchased the same high efficiency measure in the absence of the program. The third measurement combined responses to the quantity and timing questions with responses to a statement that asked respondents to rate on a 0-10 scale if, in the absence of the program, they would have paid the additional rebate amount in order to purchase the high efficiency equipment on their own. The final measurement combined responses to the quantity and timing questions with participant responses, using a 0-10 scale, to whether they agreed that the program was a critical factor in their decision to purchase the high efficiency equipment. In cases where responses were inconsistent among the four measurements, an analyst reviewed responses to open-ended questions that asked for clarification of the inconsistency, and recoded the four measurements as needed.

These four measurements were averaged to derive the final free-ridership estimate at the measure level. Prior to finalizing the NTGR algorithm, the committee conducted iterative testing with a partial dataset. This testing contributed to the reliability of the algorithm and its computer coding.

---

[10] California Public Utilities Commission. *Guidelines for Estimating Net-To-Gross Ratios Using the Self-Report Approaches.* Prepared by the Energy Division and the Master Evaluation Contractor Team. 2007.

[11] California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals. Prepared by TecMarket Works for the California Public Utilities Commission.

***Discrete Choice Approach***

In addition to the self-report approach, a discrete choice approach was utilized in the net-to-gross assessment but only for linear fluorescent and high bay measures. The analysis relies on data gathered from participant and nonparticipant phone surveys and program tracking data and focuses only on key measures likely to be installed outside of the program. Appendix F provides the discrete choice detailed methodology. Please note that this approach was only applied to customers participating in the downstream rebate Express programs.

Once the discrete choice model results are obtained, the net-to-gross ratios are calculated as follows:

1. The probability of choosing a high efficiency option with the programs in place is calculated from the model results.
2. The probability of choosing a high efficiency option without the program is calculated by setting all the program-related variables to zero (i.e., rebates, awareness) in the probability formula.
3. The difference in these two probabilities is divided by the original probability calculated in Step 1 and then weighted by the ex ante gross impact values at the measure level.

<u>The Discrete Choice Model</u>

The discrete choice model combines customers' responses about their equipment choices and purchase decision process with information on measure costs and savings impacts to estimate the probability that alternative equipment options will be chosen. It also provides a method for estimating the importance of various equipment and program factors on the equipment choice decision.

The customer equipment purchase decision process is estimated using a nested logit (NL) model. This model allows different stages in the customer purchase decision to be included in one comprehensive model and can incorporate the influences of the Small Commercial programs. Each decision stage is estimated with the relative benefits of each stage linked to the other stages through an "inclusive value" variable. The results will be used to estimate a net-to-gross ratio as a function of free ridership rates associated with the program.

The nested logit model specification has a dependent variable with a value of either zero or one. Customers are given a value of one indicating their actual equipment choice and a zero for all non-chosen alternatives. The nested logit model specification is defined as:

$$EE\ CHOICE = \alpha' Rebate + \beta' MeasureCost + \rho' X + \gamma' Y + \vartheta' Z + \varepsilon$$

The coefficients on *Rebate* and *Measure Cost* apply to all equipment choices. The explanatory variables *X*, *Y*, and *Z* contain choice-specific variables (*Awareness*, *Building Age*, *Square Feet*, *Lease*, *New*) for the T8, T5, and No-Purchase equipment choices, respectively. These coefficients are estimated for each of the four choices minus one, and in this model, the T10/T12 equipment option is treated as the base case and therefore dropped from the estimation.

The following table shows the specific variables included in the nested logit model.

**Table 3-18: Description of Model Variables**

| Variable | Description | Data Type | Source |
|---|---|---|---|
| Rebate | Rebate available to each business for T5 and T8 linear fluorescent; Rebate equals zero for T10/T12 and no-purchase options and for all choices if unaware of EE program. | Continuous | Tracking data, ECONW calcs |
| Measure Cost | Purchase cost associated with each lighting choice; For no-purchase option, cost is equal to 1/15 of cost of T10/T12 lighting cost as an estimate of annual maintenance cost. | Continuous | Tracking data, ECONW calcs |
| Awareness | Indicates awareness of EE program. | Binary | P/NP Survey |
| Building Age | Age in years of building. | Continuous | P/NP Survey |
| Building Square Feet | Natural logarithm of square feet. Log specification was chosen as way to break collinearity relationship with rebate and measure cost variables, which are based on square feet of facility. | Continuous | P/NP Survey |
| Lease | Indicates that the business leases their building. | Binary | P/NP Survey |
| New | Indicates whether business is in the new 2006-08 program sample or in the old 2004-05 program sample. | Binary | P/NP Survey |

The model sample data include nonparticipants from the 2004-05 program evaluation in order to provide additional data points to our sample and create a more robust model. The nonparticipant survey for the 2004-05 evaluation was conducted during the 2006-08 program cycle, so these data provide relevant nonparticipant information to the current evaluation. Participants who did not purchase linear fluorescents as part of their program participation are not included in the model. Table 3-19 below shows the breakdown between participants and nonparticipants from 2004-05 and 2006-08 for the sample used in the final model.

**Table 3-19: Model Sample**

| Group | Sample Size |
|---|---|
| Participants 2006-08 | 620 |
| Nonparticipants 2004-05 | 2,939 |
| Nonparticipants 2006-08 | 1,039 |
| **Total** | **4,598** |

## 3.4 Confidence and Precision of Key Findings

As stated earlier, the overall objective of this study is to estimate the mean lifetime avoided cost savings associated with installing each of these five HIMs, measured with a high level of confidence. The target level of precision at the IOU portfolio level for each of these five HIMs is as follows: 90/10 for downstream CFLs and linear fluorescent lighting, 90/15 for high bay lighting, and 90/20 for downstream CFLs. Initially, a 90/30 level of precision was planned for occupancy sensors, assuming load data analysis could be performed.

### *3.4.1 Key Findings Parameters*

***HIMs***

For linear fluorescents, high bay lighting, and interior screw lighting, the following key study findings are developed:

- Verification/installation rates,
- kW and kWh unit energy savings values,
- Baseline and post hours of use,
- Baseline and post wattage values, and
- Net-to-gross ratios.

For upstream interior screw lighting, in addition to the above listed key study findings, the following was also developed:

- Residential/nonresidential distribution of installations.

For occupancy sensors, net-to-gross ratios are the only study findings developed. Estimates of unit energy savings values were attempted through the pre-post lighting logger study. However, only six customers that participated in this study had occupancy sensors installed, which was not sufficient to develop ex post estimates of unit energy savings. As a result, verification analysis was also not feasible, as this data collection was to be conducted in conjunction with the monitoring study.

Primary data that were collected as part of this evaluation in order to support the estimates for these key findings included the following:

- Telephone surveys,
- On-sites, and
- Lighting loggers.

Only telephone survey data are used to support the net-to-gross estimates for occupancy sensors and additional primary data for linear fluorescent and high bay lighting included:

- Spot watt measurement.

### 3.4.2 Planned Confidence and Precision Levels

***Telephone Surveys***

For linear fluorescent and interior screw lighting, telephone survey sample sizes were developed to support an estimate of the net-to-gross ratio with a 10% level of precision measured at the 90% confidence interval (i.e., 90/10), at the portfolio level for each IOU.

For high bay lighting, a similar level of precision and confidence interval were developed at the portfolio level only for PG&E. Because the sample frame was significantly less for SCE and SDG&E, the expected level of precision was expected to be just 90/20 for these two IOUs.

The RRCG is conducting the net-to-gross analysis for upstream interior screw lighting, and expects to estimate the net-to-gross ratio with a 10% level of precision measured at the 90% confidence interval (i.e., 90/10), at the portfolio level for each IOU.

Telephone survey sample sizes for upstream interior screw lighting were developed to support an estimate of the residential-nonresidential distribution of installations. The measurement objective focused on developing an estimate of the nonresidential upstream CFL sales with a 10% level of precision measured at the 90% confidence interval (i.e., 90/10), at the portfolio level for each IOU.

For occupancy sensors, telephone survey sample sizes were developed to support an estimate of the net-to-gross ratio with a 10% level of precision measured at the 90% confidence interval (i.e., 90/10) at the portfolio level for PG&E and at the 90/15 level for SDG&E. Net-to-gross analysis was not planned by the SCCG for occupancy sensors in SCE territory.

***Verification On-Site Samples***

On-site sample sizes were developed to support an estimate of the verification/installation rate for four of the five HIMs. For downstream and upstream interior screw lighting, storage rates were also developed. On-sites were not conducted for occupancy sensors. The initial verification study was developed with the objective of estimating a verification rate at 90/5 level of precision at the portfolio level for each IOU across all measures, not by HIM. Precision goals at the HIM level were not specified in the HIM evaluation plan.

- Linear fluorescents were expected to be measured at the 90/10 level of precision at the portfolio level for each IOU.
- High bay lighting was expected to be measured at the 90/20 level of precision at the portfolio level for each IOU.
- Interior screw lighting was expected to be measured at the 90/10 level of precision at the portfolio level for PG&E and SCE and at the 90/15 level for SDG&E.
- Upstream interior screw lighting was expected to be measured at the 90/10 level of precision at the portfolio level for each IOU.

***Lighting Logger Samples***

The lighting logger sample design was developed to estimate the mean lifetime avoided cost savings at the 90/10 level of precision for linear fluorescent lighting and upstream interior screw lighting, 90/15 level of precision for high bay lighting, and 90/20 level of precision for downstream interior screw lighting, at the portfolio level for each IOU. The evaluation plan did not specify a precision measurement goal for baseline or post hours of use and wattage values, or kW and kWh UES estimates. The mean lifetime avoided cost savings was considered to be the primary measurement objective for this evaluation and, therefore, the sample design was planned around this objective.

During the implementation of this evaluation, the evaluation team encountered difficulties in recruiting high bay lighting vendors to assist with the pre-post lighting logger study. As a result, just the post-only sample size quotas were met, having a direct affect on the achieved levels of precision for high bay lighting.

For occupancy sensors, the lighting logger sample design was developed with the expectation that a portion of the customers participating in this study would have installed occupancy sensors in conjunction with linear fluorescent and high bay lighting. The expectation was that it would be possible to estimate the mean lifetime avoided cost savings at the 90/30 level of precision, at the portfolio level for each IOU. However, as discussed above, very few participants installed occupancy sensors that were part of the lighting logger study. Therefore, no gross impact analysis was conducted for this measure.

Similarly, verification rates were expected to be estimated based on these monitoring on-sites and measured with a 90/20 level of precision. However, this was not possible due to the lack of customers installing occupancy sensors as part of the statewide lighting logger study.

### *3.4.3 Achieved Confidence and Precision Levels*

The following discusses the actual levels of precision that were achieved for measuring each of these key parameters.

***Net-to-Gross Ratios***

The relative precisions associated with the 90% confidence intervals for the net-to-gross ratios are presented below by HIM and IOU. For the most part, these levels of precision exceeded those planned as discussed above, with the exception of high bay lighting in SCE (at 12%) and occupancy sensors in PG&E (at 11%). The RRCG is conducting the net-to-gross analysis for upstream interior screw lighting.

**Table 3-20: Relative Precision for NTG Estimates Measured at the 90% Confidence Level for Downstream Lighting HIMs, by IOU**

| Measure Group | Utility | Relative Precision |
|---|---|---|
| CFL | PGE | 7.1% |
| | SCE | 4.3% |
| | SDGE | 4.5% |
| High Bay Lighting | PGE | 5.8% |
| | SCE | 12.2% |
| | SDGE | 3.6% |
| Linear Fluorescent | PGE | 4.3% |
| | SCE | 2.2% |
| | SDGE | 1.4% |
| Occupancy Sensors | PGE | 10.7% |
| | SDGE | 9.3% |

Also presented in Table 3-21 are the 90% confidence intervals for the net-to-gross ratios presented by HIM and program. For many of the program level results, the net-to-gross ratios were estimated in the neighborhood of a 90/10 level of precision. The study was not designed to meet program-specific levels of precision for the net-to-gross ratios for a given HIM.

**Table 3-21: Relative Precision for NTG Estimates Measured at the 90% Confidence Level for Downstream Lighting HIMs, by IOU and Program**

| HIM | Program | Relative Precision |
|---|---|---|
| CFL | PGE2016 | 11.2% |
| | PGE2017 | 25.8% |
| | PGE2021 | 14.6% |
| | PGE2054 | 9.8% |
| | PGE2080 | 12.3% |
| | SCE2511 | 3.0% |
| | SCE2517 | 16.8% |
| | SDGE3012 | 20.1% |
| | SDGE3020 | 4.8% |
| High Bay Lighting | PGE2080 | 5.8% |
| | SCE2517 | 12.2% |
| | SDGE3012 | 8.8% |
| | SDGE3020 | 2.6% |
| Linear Fluorescent | PGE2017 | 4.8% |
| | PGE2021 | 4.9% |
| | PGE2054 | 6.9% |
| | PGE2080 | 6.4% |
| | SCE2511 | 1.6% |
| | SCE2517 | 6.4% |
| | SDGE3012 | 14.0% |
| | SDGE3020 | 1.4% |
| Occupancy Sensors | PGE2080 | 10.7% |
| | SDGE3012 | 29.2% |
| | SDGE3020 | 4.9% |

The net-to-gross analysis was also conducted for a number of non-HIM measures. The relative precision estimates for these measures are presented below in Table 3-22 by IOU.

**Table 3-22: Relative Precision for NTG Estimates Measured at the 90% Confidence Level for Non-HIM measures, by IOU**

| Non-HIM | Utility | Relative Precision |
|---|---|---|
| *Weighted by kWh* | | |
| Other | PGE | 13.8% |
| | SCE | 5.1% |
| | SDGE | 13.6% |
| *Weighted by Therms* | | |
| Boiler | PGE | 18.6% |
| Other | PGE | 9.5% |
| | SCG | 15.6% |
| | SDGE | 472.5%* |

* Note that relative precision is a value that is divided by the NTGR. Because the NTGR is only 1% for "Other" SDG&E, the resulting relative precision is very high. However, the margin of error is only 5% for this estimate.

***<u>Verification Rates</u>***

The relative precisions associated with the 90% confidence intervals for the various verification related measurement are presented in Table 3-23 through Table 3-26 by HIM and IOU. Included are the relative precision for the verification rates (defined as installed and operable) for linear and high bay fixtures, along with the percent of rebated measures determined to have actually been received by the participants. For CFLs, a storage rate was also estimated. Finally, for upstream CFLs, burnout rates were estimated. The relative precision for each of these estimates is presented below by HIM and IOU.

Again, these levels of precision exceeded those planned as discussed above for the verification rates. Although samples were not designed to achieve a specific level of precision for the received rate, the storage rate, or the burnout rate, these levels of precision are all measures with a high degree of reliability. It is important to note that while the relative precision on the storage rates may look high, it is an artifact of the calculation, which divides the margin of error by the mean rate. Because storage rates are significantly lower than the other rates presented, the level of precision appears to be worse. However, if one were to look at the margin of error, the level of precision would be similar for storage rates relative to the other measurements.

**Table 3-23: Linear Fluorescents – Verification and Received Rates with 90% Confidence Intervals by IOU**

| | Verification Rate | | Received Rate | |
|---|---|---|---|---|
| | Rate | Relative Precision | Rate | Relative Precision |
| PG&E | 92% | 2.7% | 88% | 2.3% |
| SCE | 95% | 4.2% | 68% | 6.3% |
| SDG&E | 89% | 8.0% | 96% | 2.0% |

**Table 3-24: High Bay Lighting – Verification and Received Rates with 90% Confidence Intervals by IOU**

| | Verification Rate | | Received Rate | |
|---|---|---|---|---|
| | Rate | Relative Precision | Rate | Relative Precision |
| PG&E | 92% | 5.2% | 93% | 5.1% |
| SCE | 93% | 5.8% | 95% | 5.7% |
| SDG&E | 100% | 1.8% | 100% | 1.7% |

**Table 3-25: Downstream CFL – Verification, Received, and Storage Rates with 90% Confidence Intervals by IOU**

| | Verification Rate | | Received Rate | | Storage Rate | |
|---|---|---|---|---|---|---|
| | Rate | Relative Precision | Rate | Relative Precision | Rate | Relative Precision |
| PG&E | 77% | 3.3% | 88% | 2.3% | 12% | 19.3% |
| SCE | 61% | 6.6% | 68% | 6.3% | 8% | 10.7% |
| SDG&E | 83% | 8.7% | 96% | 2.0% | 15% | 65.8% |

**Table 3-26: Upstream CFL – Installation and Storage Rates with 90% Confidence Intervals by IOU**

| | Verification Rate | | Storage Rate | |
|---|---|---|---|---|
| | Rate | Relative Precision | Rate | Relative Precision |
| PG&E | 73% | 4.9% | 19% | 19% |
| SCE | 81% | 1.6% | 9% | 44% |
| SDG&E | 76% | 1.9% | 14% | 26% |
| Total | 76% | 2.3% | 15% | 16% |

***<u>Gross Impact Parameters</u>***

The relative precisions associated with the 90% confidence intervals for the pre- and post-retrofit wattages, annual operating hours, peak diversity factors, and kW and kWh UES values are presented in Table 3-23 through Table 3-26 by HIM and IOU.

As discussed above, the targeted levels of precision were planned around estimating avoided cost savings. This would be highly correlated to the annual hours of operation. For the most part, the levels of precision for operating hours were close to those planned. For linear fluorescents, the target was 10% and the achieved ranged from 6% to 12% for annual operating hours. For upstream CFLs, the target was also 10% and the achieved ranged from 7% to 10% for annual operating hours. For downstream CFLs, the target was 20% and the achieved ranged from 9% to 33% for annual operating hours. The 33% was for SDG&E and was, in part, a result of the sample design allocating only 20% of the sample to SDG&E and 40% to PG&E and SCE (as PG&E and SCE contributed significantly more savings to this HIM). Finally, for high bay lighting, the target was 15% and the achieved ranged from 16% to 33% for annual operating hours. This was primarily because only about one-third of the sample size was actually achieved for the high bay lighting logger study.

**Table 3-27: Linear Fluorescents – 90% Confidence Interval Relative Precision Estimates for Gross Impact Parameters**

| | Wattage | | Usage | | Unit Energy Savings | |
|---|---|---|---|---|---|---|
| | Pre-Retrofit Wattage | Post-Retrofit Wattage | Annual Operating Hours | Peak Diversity Factor | kWh | kW |
| PG&E | 5% | 3% | 12% | 6% | 14% | 10% |
| SCE | 5% | 2% | 7% | 6% | 11% | 10% |
| SDG&E | 5% | 3% | 6% | 5% | 9% | 9% |

**Table 3-28: High Bay Lighting – 90% Confidence Interval Relative Precision Estimates for Gross Impact Parameters**

| | Wattage | | Usage | | Unit Energy Savings | |
|---|---|---|---|---|---|---|
| | Pre-Retrofit Wattage | Post-Retrofit Wattage | Annual Operating Hours | Peak Diversity Factor | kWh | kW |
| PG&E | 16% | 14% | 16% | 13% | 24% | 22% |
| SCE | 24% | 18% | 25% | 33% | 36% | 41% |
| SDG&E | 15% | 27% | 33% | 27% | 45% | 42% |

**Table 3-29: Downstream CFL – 90% Confidence Interval Relative Precision Estimates for Gross Impact Parameters**

| | Wattage | | Usage | | Unit Energy Savings | |
|---|---|---|---|---|---|---|
| | Pre-Retrofit Wattage | Post-Retrofit Wattage | Annual Operating Hours | Peak Diversity Factor | kWh | kW |
| PG&E | 1% | 2% | 9% | 9% | 9% | 9% |
| SCE | 1% | 3% | 9% | 9% | 9% | 9% |
| SDG&E | 1% | 5% | 32% | 33% | 32% | 33% |

**Table 3-30: Upstream CFL – 90% Confidence Interval Relative Precision Estimates for Gross Impact Parameters**

| | Wattage | | Usage | | Unit Energy Savings | |
|---|---|---|---|---|---|---|
| | Pre-Retrofit Wattage | Post-Retrofit Wattage | Annual Operating Hours | Peak Diversity Factor | kWh | kW |
| PG&E | 1% | 4% | 9% | 11% | 9% | 12% |
| SCE | 1% | 4% | 10% | 10% | 10% | 10% |
| SDG&E | 1% | 5% | 7% | 8% | 8% | 8% |

## 3.5 Validity and Reliability

The net unit energy savings values and 8760 load impacts are based on a number of intermediate results. Net impacts are based on estimates of free ridership, pre and post wattage, operating hours, nonresidential upstream CFL purchase quantities, and installation/verification rates. This evaluation took steps to increase both the validity and reliability of the measurement for each of these parameter estimates, as discussed below.

### *3.5.1 Minimizing Response Bias for Survey Based Results and Recruitment*

This evaluation conducted thousands of telephone surveys that supported the development of the above impact parameters in the following way:

- Free ridership was based on a self-report analysis utilizing telephone surveys for all downstream measures. Discrete choice analysis was used to validate free ridership for linear fluorescents and high bay lighting, which also used participant and nonparticipant telephone surveys.
- Billing analysis was used to statistically adjust the per unit energy savings values, which utilized participant telephone surveys.
- The nonresidential upstream CFL purchase quantities were based on a survey of the general nonparticipant population.

- Participants were recruited through the telephone survey to participate in the lighting logger study, which was used to support the development of operating hours.
- Participants were also recruited through the telephone survey to participate in on-site visits, which were used to gather information to support the pre and post wattage, nonresidential upstream CFL purchase quantities, and installation/verification rates.

All of these surveys were conducted using a Computer Aided Telephone Interview (CATI) system. A key step to ensuring the validity and reliability of these results was to minimize non-response bias. One step taken to minimize non-response bias was to attempt to contact a respondent multiple times over different times of the day, different days of the week, and different weeks of a month. Detailed disposition codes were updated after each attempted contact. For commercial customers, customers were called during normal business hours, Monday through Friday. Callbacks were also scheduled for respondents at a time that was most convenient for them. Respondents were also able to complete just a portion of the survey during the initial contact and schedule a time to complete it later.

Often times, different response rates are achieved for different market segment and customer size. For these survey activities, customers were generally stratified by market segment (which include some size segmentation) and quotas set by strata. Larger customers and those that are part of large chain accounts were also generally segmented with separate quotas as well.

Because the data collection efforts incorporated a stratified sample design by market segment, such that segment level results could be weighted up to a population estimate, non-response bias was significantly minimized. Response rates were examined by segment to identify if any groups of customers had relatively low response rates. For some of the on-site data collection activities, some strata were identified as having relatively low response rates. Therefore, an incentive was offered to customers to participate in the on-site study, which vastly improved the response rate.

### 3.5.2 Free Ridership

Free ridership was based on a self-report analysis utilizing telephone surveys for all downstream measures. The questions and algorithm used to estimate free ridership were pretested prior to full-scale implementation. The algorithm was further tested on a partial dataset to ensure the reliability of the algorithm and its computer coding.

A critical first step in the telephone survey effort was to identify the key decision-maker(s), and then ask a set of questions that establish the mindset of the respondent relative to the context and sequence of events that led to decision(s) to adopt the energy efficiency measure or practice. Free ridership was then estimated by asking multiple questions (both quantitative and qualitative) since reliability is increased by the use of multiple items. In cases where responses were inconsistent among the multiple items, an experienced analyst reviewed responses to open-ended questions that asked for clarification of the inconsistency, and recoded the individual responses in cases where the inconsistency could be resolved.

In addition to performing a self-report analysis to estimate free ridership, a discrete choice analysis was also conducted to validate the self-report results. Discrete choice analysis was only conducted for linear fluorescent and high bay measures that were rebated through one of the Express Efficiency programs by the three IOUs.

### 3.5.3 Operating Hours

Operating hours were developed from the lighting logger data. A few aspects of the lighting logger study were undertaken to ensure the validity and reliability of these results.

At the onset of the study, a sample design was developed with objectives set for estimating lifetime avoided cost savings at a specified level of precision for various levels of segmentation.[12] Achieving these precision objectives would ensure a level of reliability in these results. Therefore, it is important that the sample design be properly developed in order to achieve the desired results. To support the sample design, logger data from the 2003 and 2004-05 Express Efficiency evaluations for CFLs and linear fluorescent fixtures (linear fluorescents were only monitored in 2004-05, with a small sample of high bay fixtures included) were used to estimate sample sizes. Using actual logger data from previous studies significantly improves the validity and reliability of the calculated sample sizes, which in turn improves the likelihood of achieving the desired levels of precision, which leads to more reliable results.

To ensure valid and reliable results from the on-site survey and lighting logger data, Itron conducted a series of "pilot tests." Prior to full-scale implementation of the logger study, a series of general and individual surveyor pilot tests were conducted to test the equipment, the survey form, the procedures, and the field staff. The pilot test began with field staff receiving training in a multiple day training session, consisting of both office session and field sessions (on-site surveys conducted in teams). After the training session, field staff was sent to several customer sites on their own to collect the data, install loggers, and fill out the survey form. Their survey forms were thoroughly reviewed and discussed with them. Next, they were sent back a week or two later to do an interim download of the logger data, as well as to obtain any information missed on the first visit. The interim logger data were then

[12] It should be noted that operating hours and lifetime avoided cost savings are very highly correlated, so the precision associated with the operating hours estimates would be very similar to the precision with the lifetime avoided cost savings estimates,

reviewed and again discussed with each surveyor. Any issues with logger installation techniques were discussed at that time. Once surveyors passed their pilot test, they were approved to do full-scale installations. However, even after the pilot test, the review-and-feedback process was maintained throughout the study, and the survey form and procedures were continually revised and enhanced. Feedback from the lighting logger and data quality control staff was also continuously incorporated into procedures and survey form changes. As a final note, separate pilot tests were conducted for the downstream and upstream efforts, since the downstream measures and procedures were fairly well established, but the materials and approach for the upstream effort were completely new and untested.

To ensure the reliability of the logger data further, the logger installation procedure included the use of "back-up" loggers. Back-up loggers were to be installed on the same switch or point-of-control (POC) as the primary logger but in a different fixture. A back-up logger was not to be placed side-by-side in the exact same physical location as the primary logger. In addition, switches that had more than 10 fixtures were supposed to receive a backup logger. This requirement was implemented to ensure that the largest lighting loads would still be represented in the final analysis, even if something happened to the primary logger. This was sometimes difficult to achieve for businesses that did not allow their lights to be switched off or that had bi-level switching. This was also not strictly the case for upstream measures in hotel guest rooms, where a primary and back-up might be installed on the two night stand lamps in a single room. However, using back-up loggers did provide redundancy, as well as a check for the primary logger data when both primary and back-up loggers were good.

Extensive guidelines for selecting where and how to install lighting loggers are provided in the lighting logger field installation procedure, Appendix B. These procedures include guidance on determining lighting schedule groups, the minimum and maximum number of loggers to install, placement of the logger within a fixture, single rooms served by multiple switches, difficult locations, etc. An engineering approach rather than a strict sampling approach was used to guide logger placement, with the prime objective being to represent the complete range of operation of each rebated measure. Under this approach, the first step in deciding which fixtures to log was to assess the site's space use areas and distinct lighting operation schedules and points of control for the rebated lighting measures. Once the site assessment was made, the loggers were placed in all space use areas (or "activity areas" for this study) that had a different time or control schedule. Primary and back-up loggers would be installed on the largest representative clusters of rebated measures, and then a single logger used for each of the remaining fixtures. In some cases, loggers could not be installed, and surveyors were instructed to provide an explanation. Loggers were not supposed to be installed on outside lighting fixtures for this study, though some were installed on covered patios and protected walkways.

Baseline operating hours have historically been an area with relatively high uncertainty. In many cases, baseline operating hours have been assumed to be the same as post-retrofit operating hours. To increase the reliability of the baseline operating hour estimates, pre-retrofit time of use monitoring data was collected on a subsample of the linear fluorescent participants in the lighting logger study. Furthermore, all customers were asked if they had made any changes in the operation of their lighting systems since their retrofit, to get a self-report estimate of baseline usage.

### 3.5.4 Nonresidential Upstream CFL Purchase Quantities and Installation Rates

The primary data source for estimating the nonresidential CFL purchase quantities was through self-report responses on a general nonresidential population survey. Steps were taken to improve on the reliability and validity of the customers' responses about CFLs that they purchased through the upstream program. To ensure the reliability and validity of the number of CFLs they reported, customers were also asked to provide the number of packages of CFLs they purchased and the number of CFLs per package. This helped validate the number they reported. More importantly, however, was that a subset of these customers was visited on site, so that the purchase quantities could be verified. An adjustment factor was developed based on the on-site data that estimated the percentage of CFLs that were reported to have been purchased that were actually found on-site (customers visited on-site also reported CFLs that had burned out or were replaced for other reasons, which counted as purchases, but would not be seen on site). The adjustment factor could then be applied to the overall set of responses to improve the reliability and validity of the telephone survey self-reports. Multiple adjustment factors were developed by a segmentation scheme to improve the reliability of the adjustment process. These on-site visits were also used to determine installation rates for purchased CFLs.

Although customers were asked during the survey if the CFLs they purchased were rebated or discounted by the store, on-site data was used to validate the telephone response in order to ensure that customers actually purchased CFLs that were discounted through the upstream program. During the on-site visit, the CFL manufacturer and model numbers were collected and compared against the database of lamps that were rebated through the program (unfortunately this could not be done for SDG&E as a full list of rebated manufacturer and model numbers was not available). Again, adjustment factors could be estimated from the on-site sample and applied to the larger telephone survey sample to improve the reliability of the purchase quantities that were actually purchased through the upstream program.

### 3.5.5 Pre and Post Wattages

The reliability and validity of baseline and post-retrofit wattage values for linear fluorescent fixtures was improved through this evaluation by collecting spot watt measurements and manufacturer and model numbers for lamps and ballasts on both pre- and post-retrofit measures. Spot watt measurements were taken both with and without a "current amplifier" that was created for this study (see Appendix C) and used to increase the accuracy of single fixture wattage measurements. Spot watt measurements were compared to post retrofit manufacturer specifications and were found to be nearly identical, both validating the spot watt measurement's accuracy, and the reliability of manufacturer data for new equipment. However, it was believed that manufacturer data for pre-existing equipment would not be as reliable as the systems are old, may be partially failing and may have undergone changes that could affect the wattage of the fixtures. This hypothesis was validated though the comparison of spot watt measurements as well as the observed menagerie of pre-retrofit lighting fixture configurations (e.g., mixed T12 and T8 lamps, mixed wattage T12 lamps, etc.). Therefore, for linear fluorescent fixtures, spot watt measurement data was used to estimate baseline wattages and manufacturer data was used for post-retrofit wattages.

For CFLs, manufacturer and model information were collected on site for post-retrofit measures to validate the wattage of the lamps installed, rather than simply relying on program tracking data. Self-report data was collected on site on the wattage of pre-existing equipment to improve the reliability of baseline wattage estimates. Regression analysis was performed to develop relationships between pre- and post-retrofit wattages and then applied to the population of program tracking data to provide more accurate estimates of baseline wattage for CFLs. This analysis was segmented by upstream versus downstream CFLs to improve the reliability of estimates that were applied.

### 3.5.6 Billing Analysis

Billing analysis was conducted for linear fluorescent and high bay measures. The gross per unit energy savings estimates developed as part of this evaluation were used as inputs to the billing analysis. The billing analysis statistically adjusts these impacts to help correct or improve the reliability of the underlying estimates for wattage and operating hours and installation rates.

# 4

# Detailed Findings

This section presents the results of the impact assessment conducted for energy saving lighting technology HIMs and non-HIMs offered through the California IOUs’ 2006-2008 small commercial programs. The objectives of the study include estimating installation rates, gross kW and kWh unit energy savings values, hours of use, wattage values, and NTG ratios for measures for linear fluorescents, high bay lighting, downstream CFLs and upstream CFLs; and estimating NTG ratios for occupancy sensors and a number of non-HIMs.

## 4.1 Gross Impact Results

### *4.1.1 On-Site Verification*

An analysis of on-site data was conducted to determine the percentage of rebated measures that were actually installed and operable (this included an assessment of the number of CFLs that were placed in storage and for upstream CFLs, the number that had burned out). Verification rates (the percentage of fixtures and lamps found to be in place and operable) were estimated by IOU, program and HIM. Similarly, for CFLs, a storage rate was calculated (the percent of CFLs found in storage), and estimated at the IOU, program and HIM level. Finally, for upstream CFLs, a burn out rate was also calculated (the percent of CFLs that had burned out since installation), and estimated at the IOU level.

Although the verification rate is defined as the percent found to be in place and operable, an analysis was also conducted to determine the percent of rebated measures that were actually received by a participant. The percent received would include those in place and operable, burned out or replaced, placed in storage, or placed at another facility.

Table 4-1 presents the verification rates (defined as installed and operable) for linear and high bay fixtures, along with the percent of rebated measures determined to have actually been received by the participants. Table 4-2 presents the verification and storage rates for downstream CFLs, along with the percentage received. Table 4-3 presents the verification, storage and burnout rates for upstream CFLs.

Please note that for Table 4-2, the percent installed and operable plus the storage rate may not equal the percent received, as some lamps received may have burned out or been placed at another location.

For Table 4-3, the percent installed and operable, plus the storage rate, plus the burnout rate equal 100% (although due to rounding issues some may appear to add to 99%). For upstream CFLs, the total nonresidential count that was estimated is equal to all the upstream CFLs that were found installed and operable, placed in storage, or were reported being burned out. CFLs that were purchased and placed in another location were not included in the total nonresidential population count for upstream CFLs (therefore, received would also equal 100% for upstream CFLs, but is not reported in the table).

**Table 4-1: Installed and Operable Verification Rates and Percent of Rebated Measures Received by IOU and Program for Linear Fluorescent and High Bay Lighting**

| HIM | IOU | Program | Installed and Operable | % Received |
|---|---|---|---|---|
| HIGH BAY | PG&E | PGE2080 | 92% | 93% |
| HIGH BAY | SCE | SCE2517 | 93% | 95% |
| HIGH BAY | SDG&E | SDGE3012 | 104% | 104% |
| HIGH BAY | SDG&E | SDGE3020 | 97% | 98% |
| LINEAR | PG&E | PGE2016 | 92% | 92% |
| LINEAR | PG&E | PGE2017 | 97% | 97% |
| LINEAR | PG&E | PGE2021 | 95% | 97% |
| LINEAR | PG&E | PGE2054 | 98% | 98% |
| LINEAR | PG&E | PGE2080 | 88% | 91% |
| LINEAR | SCE | SCE2511 | 93% | 93% |
| LINEAR | SCE | SCE2517 | 97% | 98% |
| LINEAR | SDG&E | SDGE3012 | 78% | 78% |
| LINEAR | SDG&E | SDGE3020 | 91% | 92% |

**Table 4-2: Installed and Operable Verification Rates, Storage Rates, and Percent of Rebated Measures Received by IOU and Program for Downstream CFLs**

| IOU | Program | Installed and Operable | Storage Rates | % Received |
|---|---|---|---|---|
| PG&E | PGE2016 | 91% | 5% | 97% |
| PG&E | PGE2017 | 85% | 2% | 93% |
| PG&E | PGE2021 | 98% | 2% | 100% |
| PG&E | PGE2054 | 83% | 2% | 87% |
| PG&E | PGE2060 | 93% | 7% | 100% |
| PG&E | PGE2080 | 74% | 11% | 86% |
| SCE | SCE2511 | 67% | 3% | 76% |
| SCE | SCE2517 | 60% | 6% | 66% |
| SDG&E | SDGE3012 | 99% | 0% | 99% |
| SDG&E | SDGE3020 | 67% | 35% | 94% |

**Table 4-3: Installed and Operable Verification Rates, Storage Rates and Burnout Rates by IOU for Upstream CFLs**

| IOU | Installed and Operable | Storage Rates | Burn out Rate |
|---|---|---|---|
| PG&E | 73% | 19% | 7% |
| SCE | 81% | 9% | 9% |
| SDG&E | 76% | 14% | 10% |
| **Total** | **76%** | **15%** | **8%** |

## 4.2 Logger Results

The primary objectives of the lighting logger analysis were to develop 8760 impact load shapes and Unit Energy Savings (UES) values for the following nonresidential lighting HIMs that will be inputs into Energy Division's Final Staff Report by IOU, program, market segment, and measure (linear fluorescents, upstream CFLs, downstream CFLs, and high bay fixtures).

In order to calculate the impact load shape, pre-retrofit and post-retrofit load shapes are developed and the difference is the impact load shape. Pre- and post-retrofit load shapes were developed by separately estimating pre- and post-wattage and pre- and post-TOU load shapes (percent on load shapes). Therefore, for any given hour the load impact is estimated as:

$$\begin{aligned} Impact\_Hour\_i = &\left(Pre\_Wattage \times Percent\_On\_Pre\_Hour\_i\right) \\ &- \left(Post\_Wattage \times Percent\_On\_Post\_Hour\_i\right) \end{aligned}$$

Discussed below are the results for each of the individual parameters that comprise the impact load shapes and UES values, as well as the final UES values.

### *4.2.1 Operating Hours*

For linear fluorescent measures, based on the pre-post lighting logger data, it was found that the average percent on during the pre-retrofit period was 30.4% and the average percent on during the post-retrofit period was 30.0%. The difference was just 0.34% (about a 1% difference), but was not statistically significantly different from zero at the 90% confidence level. Therefore, it was determined that for linear fluorescents that the pre-retrofit load shape would utilize the post-retrofit load shape.

For CFLs and high bay measures, little or no pre-retrofit monitoring was conducted but customers were asked during the on-site visit if their lighting schedules had changed as a result of the retrofit. Linear fluorescent participants were also asked this question, which was analyzed to validate the logger results. When weighted by the number of fixtures installed, less than 1% of the linear fluorescent participants, 2% of the high bay participants, and none of the CFL participants reported a change in the way in which they operated their lighting systems after the retrofit.

Therefore, the same load shape and operating hours were used for both pre- and post-retrofit usage for the four HIMs evaluated: linear fluorescent, high bay fluorescent, and downstream and upstream CFLs.

Table 4-4 through Table 4-7 summarize the annual operating hours for linear fluorescent, high bay lighting, downstream and upstream CFLs, presented at the program type and market segment level.[1]

Because the operating hour analysis was performed at a relatively fine level of segmentation, not all combinations of program and market segment had sufficient sample to produce a unique estimate for operating hours. For linear fluorescent measures, for example, 91% of all possible program and market segment combinations were assigned operating hours based on the on-site logger analysis. For those segments that did not have estimates, operating hours were backfilled first using results for the same program-type (direct install versus downstream rebate) and market segment across all programs of that type within a given utility. This was possible for 8% of the remaining operating hours. The final 1% of operating hours was backfilled using the average program-type values across all market segments and programs of that type across all utility.

This same process was used for high bay lighting and CFLs. However, because the sample was small for high bay lighting, the analysis was conducted at the activity area across all

[1] The market segment was determined by mapping the reported building type and NAICs code found in the tracking databases to the appropriate market segment. This effort was completed for the population of the tracking data to be used in the final ED report.

market segments. Then market segment results were developed by aggregating the activity areas according to the distribution of fixtures installed across activity area within a market segment. This is why many of the operating hours are the same across market segment (as many of the market segments have the same distribution of measures installed across activity area). Appendix G discusses this process in greater detail.

**Table 4-4: Linear Fluorescent Operating Hours by Program and Market Segment**

| | PG&E | | SCE | | SDG&E | |
|---|---|---|---|---|---|---|
| **Market Segment** | **Direct Install** | **Express** | **Direct Install** | **Express** | **Direct Install** | **Express** |
| Assembly | 1,789 | 1,469 | 1,069 | 1,469 | 1,224 | 1,469 |
| Average | 2,602 | 5,817 | 1,966 | 1,800 | 2,059 | 5,446 |
| Education - Community College | 2,137 | 2,646 | 2,137 | 2,646 | 2,137 | 2,646 |
| Education - Primary School | 2,368 | 2,633 | 2,291 | 2,326 | 2,343 | 2,452 |
| Education - Secondary School | 1,222 | 2,032 | 1,222 | 2,032 | 1,222 | 2,032 |
| Education - University | 2,469 | 3,006 | 2,586 | 2,727 | 2,427 | 2,959 |
| Grocery | 3,528 | 4,637 | 3,847 | 4,637 | 4,773 | 4,637 |
| Health/Medical - Hospital | 2,813 | 3,349 | 2,813 | 3,103 | 2,813 | 2,497 |
| Health/Medical - Nursing Home | 2,955 | 3,641 | 2,830 | 3,641 | 2,848 | 3,641 |
| Lodging | 2,849 | 1,595 | 1,506 | 1,595 | 4,100 | 1,595 |
| Manufacturing - Bio/Tech | 2,469 | 3,006 | 2,586 | 2,727 | 2,427 | 2,959 |
| Manufacturing - Light Industrial | 2,252 | 3,916 | 2,280 | 3,036 | 2,250 | 3,289 |
| Office - Large | 1,958 | 2,620 | 2,198 | 3,133 | 2,030 | 2,767 |
| Office - Small | 2,017 | 2,372 | 2,293 | 2,689 | 2,199 | 2,604 |
| Restaurant - Fast-Food | 4,101 | 3,005 | 3,381 | 2,724 | 2,958 | 2,959 |
| Restaurant - Sit-Down | 3,150 | 7,387 | 3,615 | 7,387 | 3,586 | 7,387 |
| Retail - Multistory Large | 2,630 | 3,430 | 2,630 | 3,430 | 2,630 | 3,430 |
| Retail - Single-Story Large | 2,670 | 3,841 | 2,534 | 3,841 | 2,813 | 3,841 |
| Retail - Small | 2,402 | 3,343 | 2,529 | 3,587 | 2,534 | 4,055 |
| Storage - Conditioned | 2,469 | 2,609 | 2,586 | 3,048 | 2,427 | 2,772 |
| Storage - Unconditioned | 1,520 | 2,646 | 2,087 | 2,918 | 2,343 | 2,854 |

## Table 4-5: High Bay Lighting Operating Hours by Program and Market Segment

| Market Segment | PG&E | | SCE | | SDG&E | |
|---|---|---|---|---|---|---|
| | Direct Install | Express | Direct Install | Express | Direct Install | Express |
| Assembly | N/A | 2,338 | N/A | 2,338 | 2,869 | 2,338 |
| Average | N/A | 3,601 | N/A | 2,182 | 2,853 | 3,400 |
| Education - Community College | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Education - Primary School | N/A | 2,338 | N/A | 2,338 | 2,869 | 2,338 |
| Education - Secondary School | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Education - University | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Grocery | N/A | 1,979 | N/A | 1,979 | 2,869 | 1,979 |
| Health/Medical – Hospital | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Health/Medical - Nursing Home | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Lodging | N/A | 1,979 | N/A | 1,979 | 2,869 | 1,979 |
| Manufacturing - Bio/Tech | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Manufacturing - Light Industrial | N/A | 3,266 | N/A | 3,437 | 3,324 | 3,347 |
| Office – Large | N/A | 3,601 | N/A | 3,601 | 2,869 | 3,601 |
| Office – Small | N/A | 2,338 | N/A | 2,892 | 3,601 | 2,739 |
| Restaurant - Fast-Food | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Restaurant - Sit-Down | N/A | 3,241 | N/A | 2,766 | 2,869 | 3,601 |
| Retail - Multistory Large | N/A | 3,601 | N/A | 3,601 | 2,869 | 3,601 |
| Retail - Single-Story Large | N/A | 2,338 | N/A | 2,338 | 2,869 | 2,338 |
| Retail – Small | N/A | 3,184 | N/A | 3,211 | 2,540 | 3,601 |
| Storage – Conditioned | N/A | 2,887 | N/A | 2,887 | 2,869 | 2,887 |
| Storage – Unconditioned | N/A | 3,242 | N/A | 2,074 | 3,137 | 2,795 |

## Table 4-6: Downstream CFL Operating Hours by Program and Market Segment

| | PG&E | | | | | SCE | | SDG&E | |
|---|---|---|---|---|---|---|---|---|---|
| **Market Segment** | **PGE2016** | **PGE2017** | **PGE2021** | **PGE2054** | **PGE2080*** | **SCE2511** | **SCE2517*** | **SDGE3012*** | **SDGE3020** |
| Assembly | 827 | 827 | 827 | 827 | 770 | 737 | 827 | 827 | 1,546 |
| Average | 1,409 | 1,409 | 1,409 | 1,409 | 1,409 | 1,409 | 1,142 | 1,409 | 2,223 |
| Education - Community College | 1,987 | 1,987 | 1,987 | 1,987 | 1,987 | 1,987 | 1,987 | 1,987 | 1,987 |
| Education - Primary School | 2,919 | 2,919 | 2,919 | 3,114 | 2,919 | 320 | 3,404 | 2,919 | 2,919 |
| Education - Secondary School | 876 | 1,669 | 1,456 | 1,150 | 2,741 | 1,474 | 2,773 | 699 | 1,166 |
| Education - University | 876 | 1,669 | 1,456 | 1,150 | 2,741 | 1,474 | 2,773 | 699 | 1,166 |
| Grocery | 2,778 | 2,778 | 2,381 | 1,124 | 2,778 | 2,870 | 2,778 | 2,778 | 2,778 |
| Health/Medical - Hospital | 2,294 | 2,294 | 2,710 | 2,294 | 2,294 | 2,294 | 1,754 | 2,294 | 2,294 |
| Health/Medical - Nursing Home | 1,222 | 1,222 | 1,222 | 1,222 | 1,387 | 1,204 | 1,222 | 1,222 | 1,222 |
| Lodging | 876 | 820 | 1,017 | 958 | 753 | 1,444 | 709 | 693 | 749 |
| Manufacturing - Bio/Tech | 876 | 1,669 | 1,456 | 1,150 | 2,741 | 1,474 | 2,773 | 699 | 1,166 |
| Manufacturing - Light Industrial | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 | 415 |
| Office - Large | 2,753 | 2,753 | 1,344 | 2,277 | 3,119 | 2,753 | 1,556 | 2,753 | 371 |
| Office - Small | 1,503 | 1,621 | 1,148 | 1,216 | 4,100 | 1,384 | 1,292 | 1,503 | 980 |
| Restaurant - Fast-Food | 1,936 | 1,936 | 1,936 | 1,936 | 1,936 | 1,936 | 1,936 | 1,936 | 1,936 |
| Restaurant - Sit-Down | 1,371 | 1,371 | 1,371 | 1,174 | 1,371 | 1,303 | 1,371 | 1,371 | 3,157 |
| Retail - Multistory Large | 1,478 | 1,834 | 2,218 | 1,478 | 689 | 1,478 | 1,478 | 1,478 | 1,478 |
| Retail - Single-Story Large | 5,056 | 5,056 | 5,056 | 5,056 | 5,487 | 1,435 | 5,494 | 5,056 | 1,232 |
| Retail - Small | 1,496 | 1,588 | 2,293 | 1,633 | 2,051 | 1,448 | 1,496 | 2,079 | 1,127 |
| Storage - Conditioned | 2,287 | 2,287 | 2,287 | 2,287 | 2,287 | 2,287 | 2,287 | 2,287 | 2,287 |
| Storage - Unconditioned | 2,551 | 2,551 | 2,551 | 2,551 | 3,114 | 2,551 | 3,114 | 2,551 | 580 |

* These programs all have at least a component of the program that is Express Efficiency. The remaining programs are more in line with a direct installation program.

**Table 4-7: Upstream CFL Operating Hours by Program and Market Segment**

| Market Segment | PG&E | SCE | SDG&E |
|---|---|---|---|
| Agriculture | 3,521 | 3,297 | 1,217 |
| Assembly | 1,617 | 1,892 | 1,348 |
| Communications | 1,032 | 1,032 | 1,032 |
| Construction | 3,303 | 2,905 | 2,989 |
| Education - Other | 2,608 | 2,517 | 2,812 |
| Education - Secondary School | 3,278 | 3,356 | 1,025 |
| Grocery | 2,934 | 3,826 | 2,203 |
| Health/Medical | 2,489 | 2,122 | 2,063 |
| Lodging | 1,083 | 1,467 | 1,106 |
| Manufacturing - Light Industrial | 2,436 | 2,446 | 2,693 |
| Misc. Commercial | 2,202 | 1,934 | 2,552 |
| Missing | 2,687 | 2,720 | 3,645 |
| Office - Small | 3,050 | 2,836 | 2,551 |
| Restaurant | 3,705 | 3,942 | 3,909 |
| Retail | 3,243 | 2,958 | 3,004 |
| Sic 20 Food & Kindred Products | 2,669 | 2,662 | 2,854 |
| Unknown | 2,559 | 2,559 | 2,559 |
| Utilities | 4,052 | 4,052 | 4,052 |
| Warehouse | 3,980 | 2,805 | 3,111 |

### *4.2.2 Pre- and Post-Retrofit Wattages*

As discussed in detail in Appendix G, wattages for linear fluorescent and high bay lighting were based on a combination of spot watt measurements and manufacturer data. For CFLs, wattages were based on manufacturer data and self-report data.

Table 4-8 and Table 4-9 present the average pre- and post-retrofit wattage estimates by program and measure for linear fluorescent and high bay lighting. Table 4-10 presents the average pre-retrofit wattage estimates for Upstream CFLs by post-wattage values. Table 4-11 presents the average pre- and post-retrofit wattage estimates for downstream CFLs by measure.

## Table 4-8: Linear Fluorescent Average Pre- and Post-Retrofit Wattage by Program and Measure

| Utility | Measure Code | IOU Measure Name/Description | Unit Basis | PRE Watts Per Unit | POST Watts Per Unit |
|---|---|---|---|---|---|
| PGE | L290 | PREMIUM T-8/T-5 LAMP&ELECT BALLAST-REPLCE OF T-12 LAMP&BALLAST-4 FT | Lamp | 39.2 | 28.0 |
| PGE | L299 | PREMIUM T-8/T-5 LAMP&ELECT BALLAST-REPLCE OF T-12 LAMP&BALLAST-8 FT | Lamp | 71.2 | 53.8 |
| PGE | L730 | 28 WATT T8 REPLACING 32 WATT T8 | Lamp | 31.1 | 23.6 |
| PGE | L915 | PREMIUM T-8/T-5 LAMP&ELE BALLAST/NW FIX-REPL T-12 LAMP&BALLAST-4 FT 2 LAMP | Fixture | 86.9 | 45.9 |
| PGE | L924 | PREMIUM T-8/T-5 LAMP&ELE BALLAST/NW FIX-REPL T-12 LAMP&BALLAST-4 FT 3 LAMP | Fixture | 122.4 | 49.8 |
| PGE | L925 | PREMIUM T-8/T-5 LAMP&ELE BALLAST/NW FIX-REPL T-12 LAMP&BALLAST-4 FT 4 LAMP | Fixture | 142.4 | 89.5 |
| PGE | L939 | PREM T8/T5 LAMP & ELEC BALLAST/NEW FIXT-REPL T-12 LAMPS & ENGSVR BALLAST-4' | Lamp | 43.6 | 28.1 |
| PGE | L954 | FIXTURE INT LINEAR FLUORESCENT - <= 100 WATTS | Fixture | 87.1 | 54.9 |
| PGE | L955 | FIXTURE INT LINEAR FLUORESCENT - 101 - 175 WATTS | Fixture | 109.9 | 75.4 |
| PGE | LA04 | PREMIUM T-8/T-5 4LAMP 28W 2BALLAST REPALCE OF 4LAMP 40W 2BALLAST | Fixture | 152.0 | 89.1 |
| SCE | 129 | T-8 OR T-5 LAMP AND ELECTRONIC, 4-FOOT LAMP INSTALLED | Lamp | 39.7 | 28.3 |
| SCE | 187 | INTERIOR LINEAR FLUORESCENT FIXTURE 400W LAMP BASECASE, UP TO 244W RPL FIXTURE (TIER 1) | Fixture | 444.4 | 178.2 |
| SCE | T8_03 | 3RD GEN. (1) 48 T-8 LAMP WITH ELEC. BAL | Fixture | 37.2 | 29.2 |
| SCE | T8_05 | 3RD GEN. (2) 48 T-8 LAMP WITH ELEC. BAL. | Fixture | 87.5 | 58.1 |
| SCE | T8_06 | 3RD GEN. (3) 48 T-8 LAMP WITH (2) IS RLO ELEC. BAL. | Fixture | 141.0 | 89.5 |
| SCE | T8_07 | 3RD GEN. (3) 48 T-8 LAMP WITH ELEC. BAL. | Fixture | 110.3 | 88.3 |
| SCE | T8_08 | 3RD GEN. (4) 48 T-8 LAMP WITH (2) ELEC. BAL. | Fixture | 150.9 | 104.5 |
| SCE | T8_10 | 3RD GEN. (4) 48 T-8 LAMP WITH ELEC. BAL. | Fixture | 151.2 | 101.9 |
| SCE | T8_12 | (2) 96 T-12 TO (4) 48 T-8 LAMP WITH IS RLO ELEC. BAL. | Fixture | 126.4 | 104.6 |
| SCE | T8_16 | (2) 96 T-12 TO (2) 96 T-8 LAMP WITH IS RLO ELEC. BAL. | Fixture | 132.5 | 106.1 |
| SCE | T8_17 | [4] 8FT FIXTURES [4] 8FT WITH (2) IS RLO ELEC. BAL. | Fixture | 252.0 | 215.6 |
| SCE | T8_19 | (2) U-TUBE T-8 WITH IS RLO ELEC. BAL. | Fixture | 37.2 | 52.4 |
| SDGE | LGT195 | PREMIUM T8 WITH T12 34WATT BASELINE | Lamp | 32.1 | 28.2 |
| SDGE | LGT196 | PREMIUM T8 WITH T12 40 WATT BASELINE | Lamp | 54.4 | 27.9 |
| SDGE | LGT250 | LIGHTING-8 FT T-8 WITH ELEC BALLAST-TR1 | Lamp | 63.2 | 53.0 |
| SDGE | LGT251 | LIGHTING-8 FT T-8 WITH ELEC BALLAST-TR2 | Lamp | 63.2 | 52.9 |
| SDGE | LGT370 | PREMIUM T8 WITH T12 34WATT BASELINE - TR1 | Lamp | 43.6 | 28.6 |
| SDGE | LGT373 | PREMIUM T8 WITH T12 40 WATT BASELINE - TR1 | Lamp | 40.1 | 27.8 |
| SDGE | LGT374 | PREMIUM T8 WITH T12 40 WATT BASELINE - TR2 | Lamp | 40.2 | 27.5 |
| SDGE | LGT375 | PREMIUM T8 WITH T12 40 WATT BASELINE - TR3 | Lamp | 38.0 | 26.5 |

## Table 4-9: High Bay Lighting Average Pre- and Post-Retrofit Wattage by Program and Measure

| Utility | Measure Code | IOU Measure Name/Description | Unit Basis | PRE Watts Per Unit | POST Watts Per Unit |
|---|---|---|---|---|---|
| PGE | L292 | HO T-5 FIXTURE: INTERIOR, METAL HALIDE, 4 LAMP CONV, TIER-1 400 < 244 | Fixture | 378.2 | 231.2 |
| SCE | 115 | INTERIOR HIGH OUTPUT 4-6 LAMP FIXTURES T-8'S OR T-5'S | Fixture | 418.4 | 222.1 |
| SDGE | EXP07089 | LIGHTING-INTERIOR HIGH BAY LINEAR FLUORESCENT FIXTURES <= 244 WATTS REPLACING 400 WATTS (TIER 1) | Fixture | 450.7 | 188.7 |
| SDGE | LGT185 | LIGHTING-HGH OTPT 4/6 LMP T5/T8 FXTR (HI BY APP) | Fixture | 208.5 | 196.9 |
| SDGE | SBS07025 | LIGHTING-INTRHIBYLNRFLSCNTFXTR244WRPLC400W(TRI)TR1 | Fixture | 460.4 | 224.5 |
| SDGE | SBS07026 | LIGHTING-INTRHIBYLNRFLSCNTFXTR244WRPLC400W(TRI)TR2 | Fixture | 458.0 | 224.4 |
| SDGE | SBS07100 | LIGHTING-INTR HIBY LNR FLRSCNTFXTR600W RPLC>400TR1 | Fixture | 770.6 | 172.8 |

## Table 4-10: Upstream CFL Average Pre-Retrofit Wattage by Measure

| CFL Upstream Post-Wattage | Pre-Wattage Values |
|---|---|
| 3 Watt Lamp | 14.8 |
| 4 Watt Lamp | 19.8 |
| 5 Watt Lamp | 24.7 |
| 7 Watt Lamp | 34.6 |
| 9 Watt Lamp | 44.4 |
| 11 Watt Lamp | 54.3 |
| 13 Watt Lamp | 57.6 |
| 14 Watt Lamp | 59.0 |
| 15 Watt Lamp | 60.3 |
| 16 Watt Lamp | 61.6 |
| 17 Watt Lamp | 62.8 |
| 18 Watt Lamp | 63.9 |
| 19 Watt Lamp | 64.9 |
| 20 Watt Lamp | 65.9 |
| 22 Watt Lamp | 67.7 |
| 23 Watt Lamp | 68.6 |
| 24 Watt Lamp | 69.4 |
| 25 Watt Lamp | 70.2 |
| 26 Watt Lamp | 71.0 |
| 27 Watt Lamp | 71.7 |
| 28 Watt Lamp | 74.4 |
| 30 Watt Lamp | 79.7 |
| 32 Watt Lamp | 85.0 |
| 33 Watt Lamp | 87.6 |
| 40 Watt Lamp | 106.2 |
| 42 Watt Lamp | 111.6 |
| 68 Watt Lamp | 180.6 |

## Table 4-11: Downstream CFL Average Pre- and Post-Retrofit Wattages by Measure

| IOU | CFL Downstream Measure | Pre-Wattage Values | Post-Wattage Values |
|---|---|---|---|
| PG&E | 27W CFL SCREW IN | 73.5 | 27.0 |
| PG&E | CFL INT INTEGRAL - 13 WATT >= 800 LUMENS - SCREW-I | 58.5 | 13.0 |
| PG&E | CFL INT INTEGRAL - 14 WATT - SCREW-IN | 59.2 | 14.3 |
| PG&E | CFL INT INTEGRAL - 15 WATT - SCREW-IN | 59.5 | 15.0 |
| PG&E | CFL INT INTEGRAL - 16 WATT - SCREW-IN | 60.0 | 16.0 |
| PG&E | CFL INT INTEGRAL - 19 WATT >= 1,100 LUMENS - SCREW | 61.2 | 19.0 |
| PG&E | CFL INT INTEGRAL - 20 WATT - SCREW-IN | 59.2 | 14.3 |
| PG&E | CFL INT INTEGRAL - 23 WATT - SCREW-IN | 62.4 | 22.5 |
| PG&E | CFL INT INTEGRAL - 40 WATT - SCREW-IN | 108.9 | 40.0 |
| PG&E | INTERIOR CF BULB - 20 WATT >=1,100 LUMENS | 63.6 | 21.1 |
| PG&E | INTERIOR CF BULB - 23 WATT 1,400 TO 1,599 LUMENS | 62.6 | 22.9 |
| PG&E | INTERIOR CF BULB - 23 WATT >=1,600 LUMENS | 62.6 | 23.0 |
| PG&E | INTERIOR CF BULB - 42 WATT | 114.3 | 42.0 |
| PG&E | INTERIOR CF BULB - 42 WATT >=2,600 LUMENS | 114.3 | 42.0 |
| PG&E | SCREW-IN CF REFLECTOR LAMPS < 22WATTS | 59.3 | 15.6 |
| PG&E | SCREW-IN CFL LAMPS - 14 - 26 WATTS | 60.9 | 17.1 |
| PG&E | SCREW-IN CFL LAMPS - >= 27 WATTS | 76.1 | 27.4 |
| PG&E | SCREW-IN CFL LAMPS 5-13 WATTS | 46.6 | 9.0 |
| PG&E | SCREW-IN CFL REFLECTOR LAMP 15 WATTS | 59.6 | 15.2 |
| PG&E | SCREW-IN CFL REFLECTOR LAMPS - 14-26 WATTS | 60.4 | 17.3 |
| PG&E | UPSTREAM COMPACT FLUORESCENT | 62.8 | 18.2 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, 14-26 WATTS | 61.6 | 20.2 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, 14-26 WATTS REFLECTOR LAMP | 59.5 | 14.9 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, 14-26 WATTS W/ REFLECTOR (R30) | 61.3 | 19.5 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, 14-28 WATTS WITH REFLECTOR | 59.3 | 14.5 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, 5 - 13 WATTS W/ REFLECTOR (R20) | 57.3 | 11.0 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, 5 - 13 WATTS | 53.2 | 11.7 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, >27 WATTS | 67.3 | 21.2 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, >27 WATTS W/ REFLECTOR (R40) | 62.6 | 23.0 |
| SCE | SCREW-IN COMPACT FLUORESCENT LAMP, >=27WATTS | 73.5 | 27.0 |
| SCE | UPSTREAM COMPACT FLUORESCENT | 57.3 | 15.4 |
| SDG&E | LIGHTING - SCREW IN 14-26 WATT LAMP | 59.5 | 15.0 |
| SDG&E | LIGHTING - SCREW IN 14-26 WATT REFLECTOR LAMP | 59.5 | 15.0 |
| SDG&E | LIGHTING - SCREW IN >27 WATT LAMP | 71.2 | 26.1 |
| SDG&E | LIGHTING - SCREW IN >= 27 WATT LAMP | 73.3 | 26.9 |
| SDG&E | LIGHTING-REMOVE 4 FT T-8 (DE-LAMP) - TR1 | 87.1 | 32.0 |
| SDG&E | LIGHTING-SCREW IN 14-26 WATT LAMP - TR1 | 60.6 | 17.7 |
| SDG&E | LIGHTING-SCREW IN 14-26 WATT LAMP - TR2 | 60.2 | 16.0 |
| SDG&E | LIGHTING-SCREW IN 14-26 WATT REFLECTOR LAMP-TR1 | 59.5 | 15.0 |
| SDG&E | LIGHTING-SCREW IN 5- 13 WATT LAMP - TR1 | 62.6 | 23.0 |
| SDG&E | LIGHTING-SCREW IN >27 WATT LAMP - TR1 | 73.5 | 27.0 |
| SDG&E | UPSTREAM COMPACT FLUORESCENT | 63.0 | 17.9 |

### *4.2.3 Billing Analysis Realization Rates*

As discussed in Appendix H, the billing analysis was implemented by utility and delivery method. The primary focus of the billing analysis was the realized savings from linear lighting measures. Given this focus, the sample was limited to sites installing linear lighting measures, though the analysis controlled for the energy savings from other rebated measures. Prior to implementing the billing analysis, the saving values for T8s, T5s, delamping, high bays, and CFL lighting measures were adjusted to be consistent with the lighting logger analysis and the on-site verification rates. The utility ex ante savings values for non-linear, non-CFL lighting measures and other non-lighting measures were included in the analysis without engineering adjustments.

The lighting and non-lighting realization rates for sites in the prescriptive program are presented in Table 4-12. The estimated realization rate for linear measures rebated within the prescriptive programs is 113% for PG&E and 99% for SCE. Only 38 SDG&E prescriptive rebate sites remained following the data cleaning process, leaving too few SDG&E sites to estimate a prescriptive linear lighting model. Table 4-13 presents the 90% confidence interval for the linear lighting realization rates within the prescriptive program. The 90% confidence interval includes a realization rate of 100%, supporting the energy savings adjustments from the linear lighting logger and verification analyses. Given the estimated realization rates, the adjustments from the linear lighting logger study and the verification analysis will be adopted without further adjustment for the PG&E, SCE, and SDG&E prescriptive programs.

The realization rates for the non-linear lighting measures and other rebated measures are also presented in Table 4-12. The estimated realization rate for non-linear lighting measures is not statistically significant and the realization rate for other non-lighting measures is not significant with the PG&E model. The estimated realization rate for these measures should not be used to evaluate the savings from these measures because the samples drawn for this analysis were restricted to those sites installing linear lighting measures. The savings for non-linear measures were included in the model to control for possible confounding changes at the linear sites, not to determine the realization rate for these measures.

The estimated realization rates for the direct install lighting programs are provided in Appendix H. The linear lighting realization rate is not statistically significant within PG&E's model and is significantly less than 100% for SCE and SDG&E. The team has tried alternative model specifications and analyzed the data to determine possible explanations for the 100% realization rate within the prescriptive sample of sites and the lower realization rate for the direct install sample. The direct install sites are, on average, sites with substantially lower energy usage, lower claimed savings, generally lower claims relative to usage, and more sites with multiple measures installed. The lighting logger analysis made larger reductions to the energy savings for direct install sites than prescriptive sites. The direct install sites may be more vulnerable to energy changes associated with changes in both macro and micro economic conditions. While the model specifications have included independent variables designed to control for macro economic conditions, the micro economic fluctuations associated with the smaller direct install sites may be blurring the impact of the linear lighting retrofits. Give the strength of the 100% realization rate for the prescriptive sites and the substantial reductions in the direct install energy savings due to the logger analysis, the team supports the use of the lighting logger energy savings for both the prescriptive and the direct install sites. The estimated lower billing analysis realization rate for direct install needs further study. Possible areas of analysis include more complete documentation of the accounts or meters impacted by the retrofit. Failure to adequately account for all meters at a site may have a larger impact on billing analysis for smaller sites.

**Table 4-12: Monthly SAE Model Realization Rates For PG&E and SCE Prescriptive Rebate Programs**

| Regressor | PG&E EX Coefficient | PG&E EX T-Statistic | SCE EX Coefficient | SCE EX T-Statistic |
|---|---|---|---|---|
| Linear Engineering Ex Post Savings Estimate | -1.1340 | -5.81 | -0.9902 | -65.41 |
| Non-Linear Lighting Engineering Ex Post Savings Estimate | -0.2188 | -0.36 | 0.0658 | 0.40 |
| All Other Prescriptive Measures Savings Estimate | -0.0711 | -0.23 | -0.4460 | -2.68 |
| All Direct Install Measure Savings Estimate | -2.0140 | -2.07 | 1.5796 | 33.00 |
| Adjusted R Squared | 0.9035 | | 0.9936 | |

**Table 4-13: 90% Upper and Lower Bound Confidence Interval For Linear Lighting Realization Rate**

| | 90% Lower Bound | Linear Lighting Realization Rate | 90% Upper Bound |
|---|---|---|---|
| PG&E | 0.813 | 1.134 | 1.455 |
| SCE | 0.997 | 0.990 | 1.015 |

### *4.2.4 Unit Energy Savings Values*

Given the pre- and post-retrofit wattages and operating hours, the unit energy savings values can be estimated as discussed above. Literally thousands of UES values were estimated by program, market segment, and measure for linear fluorescents, high bay lighting, downstream CFLs, and upstream CFLs. These UES values are presented in detail in Appendix K. Table 4-14 provides a sample of these extensive UES by market segment for one of the more common downstream CFL measures for PG&E's most active program.

### Table 4-14: Downstream CFL UES Values for PGE2080 by Market Segment for the 14-26 Watt CFL Measure

| ED DEER Building Type | Operating Hours | Coincident Peak | Post-Wattage | Pre-Wattage | Ex Post UES kWh | Ex Post UES kW |
|---|---|---|---|---|---|---|
| ASSEMBLY | 770 | 10% | 17 | 61 | 34 | 0.004 |
| AVERAGE | 1,409 | 9% | 17 | 61 | 62 | 0.004 |
| EDUCATION-COMMUNITY COLLEGE | 770 | 10% | 17 | 61 | 34 | 0.004 |
| EDUCATION-PRIMARY SCHOOL | 1,409 | 9% | 17 | 61 | 62 | 0.004 |
| EDUCATION-SECONDARY SCHOOL | 2,741 | 42% | 17 | 61 | 120 | 0.018 |
| EDUCATION-UNIVERSITY | 2,741 | 42% | 17 | 61 | 120 | 0.018 |
| GROCERY | 2,778 | 24% | 17 | 61 | 122 | 0.011 |
| HEALTH/MEDICAL-HOSPITAL | 2,294 | 25% | 17 | 61 | 101 | 0.011 |
| HEALTH/MEDICAL-NURSING HOME | 1,387 | 24% | 17 | 61 | 61 | 0.011 |
| LODGING | 753 | 6% | 17 | 61 | 33 | 0.004 |
| MANUFACTURING-BIO/TECH | 2,741 | 42% | 17 | 61 | 120 | 0.004 |
| MANUFACTURING-LIGHT INDUSTRIAL | 415 | 11% | 17 | 61 | 18 | 0.004 |
| OFFICE-LARGE | 3,119 | 64% | 17 | 61 | 137 | 0.004 |
| OFFICE-SMALL | 4,100 | 25% | 17 | 61 | 180 | 0.018 |
| RESTAURANT-FAST-FOOD | 1,936 | 36% | 17 | 61 | 85 | 0.018 |
| RESTAURANT-SIT-DOWN | 1,371 | 21% | 17 | 61 | 60 | 0.011 |
| RETAIL-MULTISTORY LARGE | 689 | 17% | 17 | 61 | 30 | 0.011 |
| RETAIL-SINGLE-STORY LARGE | 5,487 | 86% | 17 | 61 | 241 | 0.004 |
| RETAIL-SMALL | 2,051 | 37% | 17 | 61 | 90 | 0.004 |
| STORAGE-CONDITIONED | 2,287 | 39% | 17 | 61 | 100 | 0.004 |
| STORAGE-UNCONDITIONED | 3,114 | 66% | 17 | 61 | 137 | 0.004 |

Provided in Table 4-15 are the aggregated UES values for upstream CFLs by IOU, along with the average operating hours and wattage values.

### Table 4-15: Upstream CFL UES Values by IOU

| IOU | Operating Hours | Coincident Peak | Pre-Wattage | Post-Wattage | Ex Post UES kWh | Ex Post UES kW |
|---|---|---|---|---|---|---|
| PG&E | 2,710 | 44% | 62.8 | 18.2 | 121 | 0.020 |
| SCE | 2,517 | 39% | 57.3 | 15.5 | 105 | 0.016 |
| SDG&E | 2,191 | 36% | 63.0 | 17.9 | 99 | 0.016 |

## 4.3 Net-to-Gross Results

### *4.3.1 Self-Report Results*

The calculation of free ridership is a multi-step process that considers a variety of ways in which the program may influence a customer to adopt an energy-efficient measure. The approach relies on self-report methods for all HIMs and non-HIMs, as well as a discrete choice analysis for linear fluorescent and high bay lighting. The approach for upstream CFLs relies on interviews with retailers and manufacturers. This analysis was conducted by the Residential Retrofit Contract Group and is presented in that group's report.

Participants who were involved in the decision-making process at each participating household or small commercial site were interviewed to measure the program's influence on respondents' decision-making.

The NTGR algorithm derived four separate measurements of free-ridership from different inquiry routes. These four measurements were averaged to derive the final free-ridership estimate at the measure level.

- The first measurement consisted of responses to a series of yes/no questions that measured the impact of the program on the quantity, efficiency, and timing of the purchase.
- The second measurement consisted of a 0-10 scale that asked the likelihood that the respondent would have purchased the same exact high efficiency measure in the absence of the program.
- The third measurement combined responses to the quantity and timing questions with responses to a 0-10 scale that asked the respondents' agreement with the statement that, in the absence of the program, they would have paid the additional rebate amount to buy the high efficiency equipment on their own.
- The final measurement combined responses to the quantity and timing questions with responses to a 0-10 scale that asked respondents' agreement with the statement that the program was a critical factor in their decision to purchase the high efficiency equipment.

In cases where responses were inconsistent among the four measurements, an analyst reviewed responses to open-ended questions that asked for clarification of the inconsistency, and recoded the four measurements as needed.

Table 4-16 presents the self-report free-ridership and net-to-gross ratios for each HIM based on the self-report methodology. Results are weighted by both kWh and kW savings.

## Table 4-16: Free-Ridership Findings by HIM and Program

| HIM | Program # (EEGA Code) | Free Ridership (FR) Estimates and Net-to-Gross Ratio (NTGR) Findings – kWh Weighted %FR | kWh Weighted NTGR % (1-% FR) | kW Weighted %FR | kW Weighted NTGR % (1-% FR) |
|---|---|---|---|---|---|
| CFL | PGE2016 | 27% | 73% | 18% | 82% |
| | PGE2017 | 33% | 67% | 50% | 50% |
| | PGE2021 | 34% | 66% | 31% | 69% |
| | PGE2054 | 28% | 72% | 26% | 74% |
| | PGE2080 | 45% | 55% | 40% | 60% |
| | SCE2511 | 19% | 81% | 19% | 81% |
| | SCE2517 | 52% | 48% | 48% | 52% |
| | SDGE3012 | 18% | 82% | 18% | 82% |
| | SDGE3020 | 13% | 87% | 16% | 84% |
| High Bay | PGE2080 | 32% | 68% | 32% | 68% |
| | SCE2517 | 32% | 68% | 30% | 70% |
| | SDGE3012 | 10% | 90% | 10% | 90% |
| | SDGE3020 | 1% | 99% | 1% | 99% |
| Linear | PGE2017 | 9% | 91% | 9% | 91% |
| | PGE2021 | 8% | 92% | 8% | 92% |
| | PGE2054 | 8% | 92% | 8% | 92% |
| | PGE2080 | 36% | 64% | 36% | 64% |
| | SCE2511 | 13% | 87% | 13% | 87% |
| | SCE2517 | 28% | 72% | 28% | 72% |
| | SDGE3012 | 26% | 74% | 25% | 75% |
| | SDGE3020 | 12% | 88% | 12% | 88% |
| Lighting Controls | PGE2080 | 32% | 68% | 30% | 70% |
| | SDGE3012 | 46% | 54% | 46% | 54% |
| | SDGE3020 | 11% | 89% | 26% | 74% |

Table 4-17 presents the self-report free ridership and net-to-gross ratios for the Non-HIM measures based on the self-report methodology. Results are weighted by kWh, kW, and Therm savings.

**Table 4-17: Free Ridership Findings by Non-HIM and Program**

| Non-HIM | Program # (EEGA Code) | Free Ridership (FR) Estimates and Net-to-Gross Ratio (NTGR) Findings | | | | | |
|---|---|---|---|---|---|---|---|
| | | kWh Weighted | | kW Weighted | | Therms Weighted | |
| | | % FR | NTGR % (1-FR) | % FR | NTGR % (1-FR) | % FR | NTGR % (1-FR) |
| **Boiler** | PGE2080 | - | - | - | - | 64% | 36% |
| **Other** | PGE2080 | 66% | 34% | 57% | 43% | 5% | 95% |
| | SCE2511 | 10% | 90% | 13% | 87% | - | - |
| | SCG3507 | 44% | 56% | 55% | 45% | 68% | 32% |
| | SDGE3012 | 64% | 36% | 86% | 14% | 96% | 4% |
| | SDGE3020 | 34% | 66% | 36% | 64% | 100% | 0% |

### *4.3.2 Discrete Choice Results*

The discrete choice model combines customers' responses about their equipment choices and purchase decision process with information on measure costs and savings impacts to estimate the probability that alternative equipment options will be chosen. It also provides a method for estimating the importance of various equipment and program factors on the equipment choice decision. Appendix F discusses the discrete choice analysis and results in detail. Please note that this analysis is only conducted for the Express program participants, and does not include any participants in the direct installation programs.

Coefficients from the nested logit model are shown in Table 4-18. Because of the structure of the nested logit model, the coefficients are not directly interpretable as elasticities or probabilities. The only directly interpretable information on the coefficients is their sign (either positive or negative). The vast majority of the coefficients have the expected sign. For example, the sign on *Rebate* is positive, indicating that an increase in value of a rebate will increase the probability of taking a particular action (e.g., purchasing energy efficient lighting). Likewise, the sign on the *Measure Cost* variable is negative, indicating that as the cost of a measure increases, the likelihood of choosing that measure decreases. The choice-specific program variable (*Awareness*) also has the expected positive sign for the T8 and T5 options, relative to the T10/T12 base case.

Within the nested logit model, certain coefficient estimates apply to all choices—the *Rebate* and *Measure Cost* variables—and other coefficients are estimated for each of the four choices minus one. Because there are four choices for the nested logit model (T10/T12, T8, T5, No-purchase), there are three sets of such coefficients. For the results shown in Table 4-18, *T10/T12* represents the base case.

The last two coefficients in Table 4-18 are the inclusive values (IV) parameters. The IV parameters link the two levels of the nested logit model and are used in such calculations as consumer surplus or perceived benefit of each of the choices. As is common in nested logit model estimation, one of the two IV parameters is fixed (in this case at 1.0) and the other is allowed to vary. The value of the (free) IV parameter must lie between 0 and 1.0 in order for the nested logit model to be consistent with utility maximization. In this case, the value of the free IV parameter, 0.95, is statistically significantly less than 1.0 and greater than 0, thus the nested logit model is consistent with utility maximization.

### Table 4-18: Nested Logit Coefficients

| Variable | Coefficient | Std. Err. | T-stat | Prob |
|---|---|---|---|---|
| Rebate | 0.00025 | 0.00000171 | 148.757 | < 1% |
| Measure Cost | -0.00009 | 0.00000067 | -131.103 | < 1% |
| **Coefficients for T8 Linear Lighting Purchase** | | | | |
| Awareness | 0.21772 | 0.01503 | 14.486 | < 1% |
| Building Age | -0.02148 | 0.00018 | -118.933 | < 1% |
| Log Square Feet | -0.35321 | 0.00119 | -297.155 | < 1% |
| Lease | -0.61057 | 0.00924 | -66.106 | < 1% |
| New | 0.20722 | 0.01014 | 20.441 | < 1% |
| **Coefficients for T5 Linear Lighting Purchase** | | | | |
| Awareness | 0.67203 | 0.01073 | 62.62 | < 1% |
| Building Age | -0.01712 | 0.00023 | -73.682 | < 1% |
| Log Square Feet | -0.20427 | 0.00257 | -79.421 | < 1% |
| Lease | -0.47872 | 0.00739 | -64.796 | < 1% |
| New | 0.18055 | 0.00724 | 24.936 | < 1% |
| **Coefficients for No Linear Lighting Purchase** | | | | |
| Awareness | 0.86069 | 0.02490 | 34.565 | < 1% |
| Building Age | -0.04276 | 0.00065 | -65.524 | < 1% |
| Log Square Feet | 0.04482 | 0.00452 | 9.907 | < 1% |
| Lease | -0.58096 | 0.02016 | -28.815 | < 1% |
| New | -1.56074 | 0.02273 | -68.677 | < 1% |
| **IV Parameters** | | | | |
| No EE LL Nest | 1 | ***Fixed Parameter | | |
| EE LL Nest | 0.95422496 | 0.00938464 | 101.6794422 | < 1% |

The net-to-gross ratio is calculated using the change in probability of purchasing high efficiency equipment with and without the program. As shown in the formula below, the net-to-gross ratio is the difference in the probability of purchasing high efficiency equipment with and without the program divided by the probability of purchasing the high efficiency option with the program:

$$NTG = \frac{PROB^{W}_{TOTAL\,j} - PROB^{WO}_{TOTAL\,j}}{PROB^{W}_{TOTAL\,j}}$$

where:

$PROB^{W}_{TOTAL\ j}$ = Probability of choosing option j with the Small Commercial program.

$PROB^{WO}_{TOTAL\ j}$ = Probability of choosing option j in the absence of the Small Commercial program.

A simulation was performed on the estimated coefficients from the nested logit model to calculate a net-to-gross ratio for T8 and T5 linear lighting together. The simulation exercise examined the change in the probability of purchasing either of these linear lighting choices without the rebate associated with the Small Commercial program and without awareness of the program. Table 4-19 shows the estimate of the net-to-gross ratio is 77%.

The net-to-gross ratio in Table 4-19 is calculated only for the linear fluorescent and high bay lighting measures for customers that participated in the Express downstream rebate programs. The participant subgroup of linear fluorescent and high bay lighting purchasers was divided into quintiles based on expected kWh savings for each customer, and net-to-gross ratios were calculated for each quintile. A weighted average of the ratios for each quintile was calculated to arrive at the overall program net-to-gross ratio reported below.

**Table 4-19: Net-to-Gross Calculations for Express Program Participants**

| HIM | Net-to-Gross Ratio |
|---|---|
| Linear and High Bay Lighting | **77%** |

Net-to-gross ratios were also calculated separately for linear fluorescent and high bay lighting measures for each IOU and these are shown in Table 4-20. These were calculated by the same method as described above.

**Table 4-20: Net-to-Gross by IOU for Express Program Participants**

| | Net-to-Gross Ratio | | |
|---|---|---|---|
| IOU | Overall | Linear Fluorescent | High Bay |
| Combined | 77% | 73% | 89% |
| PG&E | 74% | 64% | 87% |
| SCE | 80% | 78% | 92% |
| SDG&E | 72% | 68% | 89% |

Table 4-21 compares the resulting net-to-gross ratios for the self-report and discrete choice methodologies, by HIM and IOU.

**Table 4-21: Comparison of Self-Report and Discrete Choice Results by HIM and IOU**

| HIM | IOU | Self Report NTG | Discrete Choice NTG |
|---|---|---|---|
| Linear Fluorescents | PG&E | 73% | 64% |
| | SCE | 79% | 78% |
| | SDG&E | 87% | 68% |
| | Statewide | 79% | 73% |
| High Bay Lighting | PG&E | 68% | 87% |
| | SCE | 68% | 92% |
| | SDG&E | 95% | 89% |
| | Statewide | 73% | 89% |
| Combined | Statewide | 78% | 77% |

Overall, at the statewide level across both linear fluorescent and high bay lighting measures, net savings are within 1% of each other for the two methods (the self-report method results in slightly higher overall net savings). Statewide, the self-report values for linear fluorescents are 6% higher; for high bay lighting, discrete choice values are 16% higher. The linear fluorescent values for both approaches are based on a larger sample size, so it might be expected that there is more variation among the high bay lighting results.

One possible explanation for the different estimates obtained from the self-report and the discrete choice approaches is the level at which each of these estimates was developed. For the discrete choice model, a single model was run statewide that combined both measures across all IOUs. The model results were then used to calculate separate weighted NTG ratios by HIM and IOU. In the case of high bay lighting, the rebates were higher on average (20%) than those for linear fluorescents, which lead to the higher NTG ratios (relative to T8s) when using the discrete choice model results. In contrast, the self-report was done separately for each customer (and therefore separately by IOU and HIM). Consequently, one might expect variability when comparing results at the IOU and HIM level between the two methods. As mentioned, when comparing a weighted NTG ratio statewide across both measures, the ratios differ by only one percent.

Because the overall values differ by only one percent, Itron's recommendation is to utilize the self-report results, as this was a consistent approach applied to all the lighting HIMs in this evaluation, as well as for other HIMs evaluated by other contract groups. These discrete choice results provide some level of validity for the self-report approach.

## 4.4 Summary of Findings

Table 4-22 and Table 4-23 summarize the results at the IOU level for linear fluorescents, high bay fluorescents, and interior screw lighting, for GWh and MW savings, respectively. These tables include the total ex-ante gross savings, total ex-post gross savings, the gross realization rate (the ratio of ex post to ex ante savings, the installation rate, the installed ex-post savings, the NTGR and the resulting installed ex post net savings.

**Table 4-22: Summary of GWh Results for Linear Fluorescents, High Bay Fluorescents, and Interior Screw Lighting**

| HIM | IOU | Ex-Ante Gross Savings GWh | Ex-Post Gross Savings GWh | Gross Realization Rate | Installed Ex-Post Gross Savings GWh | Install Rate | Installed Ex-Post Net Savings GWh | Ex-Post NTG |
|---|---|---|---|---|---|---|---|---|
| Interior Screw Lighting | PG&E | 141.8 | 40.8 | 29% | 32.1 | 79% | 19.0 | 59% |
| | SCE | 145.4 | 49.2 | 34% | 30.7 | 63% | 18.6 | 61% |
| | SDG&E | 34.6 | 5.2 | 15% | 4.1 | 78% | 3.5 | 85% |
| High Bay Fluorescent | PG&E | 67.6 | 46.8 | 69% | 42.9 | 92% | 29.2 | 68% |
| | SCE | 46.6 | 34.5 | 74% | 32.3 | 93% | 22.0 | 68% |
| | SDG&E | 29.7 | 16.3 | 55% | 16.3 | 100% | 15.5 | 95% |
| Linear Fluorescent | PG&E | 82.1 | 62.3 | 76% | 57.1 | 92% | 41.7 | 73% |
| | SCE | 301.9 | 212.3 | 70% | 201.5 | 95% | 158.6 | 79% |
| | SDG&E | 169.2 | 74.4 | 44% | 66.9 | 90% | 58.3 | 87% |

**Table 4-23: Summary of MW Results for Linear Fluorescents, High Bay Fluorescents, and Interior Screw Lighting**

| HIM | IOU | Ex-Ante Gross Savings MW | Ex-Post Gross Savings MW | Gross Realization Rate | Installed Ex-Post Gross Savings MW | Install Rate | Installed Ex-Post Net Savings MW | Ex-Post NTG |
|---|---|---|---|---|---|---|---|---|
| Interior Screw Lighting | PG&E | 18.1 | 5.7 | 31% | 4.4 | 78% | 2.7 | 62% |
| | SCE | 27.3 | 7.2 | 26% | 4.5 | 63% | 2.9 | 64% |
| | SDG&E | 6.1 | 0.5 | 9% | 0.4 | 76% | 0.3 | 83% |
| High Bay Fluorescent | PG&E | 19.6 | 9.7 | 49% | 8.9 | 92% | 6.1 | 68% |
| | SCE | 14.3 | 7.8 | 55% | 7.3 | 93% | 5.1 | 70% |
| | SDG&E | 6.0 | 3.5 | 58% | 3.5 | 100% | 3.3 | 95% |
| Linear Fluorescent | PG&E | 18.7 | 14.7 | 79% | 13.5 | 92% | 10.0 | 74% |
| | SCE | 66.2 | 52.1 | 79% | 49.4 | 95% | 39.1 | 79% |
| | SDG&E | 36.2 | 19.1 | 53% | 17.3 | 90% | 15.1 | 87% |

The Residential Retrofit Contract Group (RRCG) was responsible for developing the overall net energy savings values for upstream interior screw lighting, and the SCCG was responsible for developing kW and kWh unit energy savings. Therefore, Table 4-24 summarizes the results the kW and kWh UES values developed as part of this evaluation for upstream interior screw lighting.[2]

**Table 4-24: Summary of kW and kWh UES Values for Upstream Interior Screw Lighting**

| IOU | Operating Hours | Coincident Peak | Pre-Wattage | Post-Wattage | Ex Post UES kWh | Ex Post UES kW |
|---|---|---|---|---|---|---|
| PG&E | 2,710 | 44% | 62.8 | 18.2 | 121 | 0.020 |
| SCE | 2,517 | 39% | 57.3 | 15.5 | 105 | 0.016 |
| SDG&E | 2,191 | 36% | 63.0 | 17.9 | 99 | 0.016 |

Finally, verification analysis and the lighting logger analysis were not performed for occupancy sensors or the non-HIMs, only the net-to-gross analysis was performed. Therefore, Table 4-25 summarizes the NTGRs for occupancy sensors or the non-HIMs

**Table 4-25: Summary of NTGRs for Occupancy Sensors and Non-HIMs**

| HIM | IOU | Ex-Ante Gross Savings | Ex- Ante Net Savings | Ex-Ante NTG | Ex-Post Net Savings | Ex-Post NTG |
|---|---|---|---|---|---|---|
| GWH | | | | | | |
| Occupancy Sensor | PG&E | 27.4 | 26.3 | 96% | 18.6 | 68% |
| | SDG&E | 29.2 | 28.0 | 96% | 22.0 | 75% |
| Other – Non-HIMs | PG&E | 190.4 | 179.5 | 94% | 64.7 | 34% |
| | SCE | 14.9 | 14.3 | 96% | 13.4 | 90% |
| | SDG&E | 28.8 | 27.7 | 96% | 16.7 | 58% |
| MW | | | | | | |
| Occupancy Sensor | PG&E | 6.3 | 6.0 | 96% | 4.4 | 70% |
| | SDG&E | 6.0 | 5.7 | 96% | 3.6 | 60% |
| Other – Non-HIMs | PG&E | 75.8 | 72.3 | 95% | 32.6 | 43% |
| | SCE | 1.3 | 1.3 | 96% | 1.1 | 87% |
| | SDG&E | 2.6 | 2.5 | 96% | 1.4 | 53% |
| Millions of Therms | | | | | | |
| Occupancy Sensor | PG&E | 0.89 | 0.85 | 96% | 0.32 | 36% |
| Other – Non-HIMs | PG&E | 1.92 | 1.85 | 96% | 1.82 | 95% |
| | SoCalGas | 1.54 | 1.48 | 96% | 0.49 | 32% |
| | SDG&E | 0.31 | 0.29 | 96% | 0.00 | 1% |

2 Please refer to the Upstream Lighting Evaluation Report for presentation of the full set of gross and net energy savings results.

# 5

# Conclusions and Recommendations

This final section presents conclusions and recommendations from the impact evaluation of the 2006-2008 statewide lighting technology HIMs and non-HIMs. Below, key net and gross impact parameter results are examined by market segment and by program delivery mechanisms in order to identify program areas that were more effective in providing net energy savings. Furthermore, recommendations are provided for future program evaluation efforts based on the lessons learned from this evaluation.

## 5.1 Linear Fluorescents and High Bay Lighting Conclusions

### *5.1.1 Comparison of Market Segments*

Below, results for linear fluorescents and high bay fixtures are compared across market segment for free-ridership rates, verification rates, operating hours, and unit energy savings values. Through this comparison, market segments that are more cost-effective can be identified and potentially targeted for future program efforts.

***Free Ridership***. The sample sizes for high bay lighting were not sufficient to provide results at the market segment level that could be reliably compared such that any conclusions could be drawn. However, for linear fluorescent fixtures the samples were significantly larger. Overall, 13 segments were analyzed that had a sample size of at least 30. Free ridership ranged from 11% to 26%. Eight of these segments were within 3% of the overall 17% average. Therefore, there did not appear to be any outlier segments that would be candidates to target based on low free ridership or avoid due to high free ridership.

***Verification Rates***. Overall, verification rates were fairly similar across market segments, with nearly every market segment but one having a verification rate within about 10% of the mean. The assembly market segment had the lowest verification rate of only 69% for linear fluorescents, which was based on a sample of 33 onsite visits.

***Operating Hours and Unit Energy Savings***. Again, the sample sizes for high bay lighting were not sufficient to provide results at the market segment that could be reliably compared such that any conclusions could be drawn. However, for linear fluorescent fixtures the samples were significantly larger. Of the eight market segments with sufficient sample to be compared, five had operating hours within 20% of the overall average. The only market segment that had significantly lower operating hours was assembly, which had only about 40% of the mean operating hours. The grocery market segment had the largest operating hours, about 80% more than the mean, followed by restaurants at about 40% greater than the mean.

Based on these comparisons, for linear fluorescent fixtures, grocery and restaurants are two market segments that are likely to provide higher energy savings, and assembly is likely to provide lower energy savings (based on its low verification rate and lower operating hours). There are no market segments that appear to be candidates to target based on low free ridership, or avoid due to high free ridership.

### *5.1.2 Comparison of Program Delivery Mechanisms*

The programs that offered linear fluorescents and high bay lighting can be generally classified as direct installation programs or prescriptive rebate programs. The following comparisons of results by program type provide some insight on the effectiveness of each delivery mechanism.

***Target Market***. Generally the direct installation programs targeted much smaller (and generally harder to reach) market segments. This is an important distinction, as it is one of the driving factors for the differences seen in free ridership and unit energy savings as discussed below.

***Program Costs.*** Although program costs were not evaluated as part of this program, incentives are generally higher for direct installation programs, which is also one of the driving factors for the differences seen in free ridership.

***Net-to-Gross.*** Free ridership was found to be significantly higher for the prescriptive rebate programs. For linear fluorescents, free ridership was 25% among the prescriptive programs, versus only 13% among direct installation programs. For high bay lighting, free ridership was 33% among the prescriptive programs, versus only 7% among direct installation programs. The lower free ridership values for direct installation programs are due to a combination of their target market and the way in which they deliver their program (including offering higher incentives).

***Verification Rates.*** Overall, verification rates were fairly similar, but slightly higher for direct installation programs. For direct installation programs, verification rates were 92% for linear fluorescents and 97% for high bay lighting. For prescriptive programs, verification rates were 89% for linear fluorescents and 95% for high bay lighting.

***Operating Hours and Unit Energy Savings.*** The operating hour analysis was only performed by program type for the linear fluorescent measure. Because there is a different distribution of how fixtures are installed across market segment for a given program, it is difficult to make a direct comparison at the statewide level. However, by examining operating hours at the segment level, it is clear that operating hours are generally higher for the prescriptive programs. Similarly, the unit energy savings values are also generally higher for the prescriptive programs. The higher operating hours (and therefore savings) for the prescriptive programs are partially a result of their target market being larger customers with longer business hours.

Clearly, there is a role for both direct installation programs and prescriptive rebate programs. The direct installation programs have demonstrated their ability to serve the smaller (and harder to reach) market segments at low levels of free ridership and high installation rates. The prescriptive programs are well served to attract the larger customers, where higher rates of free ridership are offset by larger program impacts and what are often times lower overall program costs because of lower incentive levels.

## 5.2 Upstream and Downstream CFL Conclusions

### *5.2.1 Comparison of Market Segments*

Below, results for upstream and downstream CFLs are compared across market segment for free-ridership rates, verification rates, operating hours and unit energy savings. Through this comparison, market segments that are more cost-effective can be identified and potentially targeted for future program efforts.

***Net-to-Gross****.* For the upstream program, the majority of market segments were within about 10% of the average free ridership rate. However, the health/medical clinic segment had significantly higher free ridership than the other market segments, about 67% compared to an overall average of 47%. For the downstream programs, there is also one market segment, lodging, which has a significantly higher free ridership rate (49%) than the average of the remaining market segments (29%).

***Verification Rates****.* For downstream CFLs, most of the market segments are within about 10% of the mean verification rate. The retail segments tended to have lower verification rates, including single story large retail (62%) and small retail (66%); whereas the office segments tended to have higher verification rates, including large offices (94%) and small offices (83%). For upstream, all the market segments were within 10% of the mean.

***Operating Hours and Unit Energy Savings****.* Overall, the market segment with the lowest level of operating hours was lodging, which was about half of the average. Within the downstream CFLs, it was even more dramatic, with operating hours that were about a third of the average of the other downstream market segments. Another segment that was relatively low was assembly, which was about 30% lower than the overall average. Again, for downstream CFLs it was even more dramatic, with operating hours that were about half of the average of the other downstream market segments. By far the market segment with the largest operating hours was large single story retail, which had operating hours more than twice the average. However, this was a result of the downstream programs in PG&E and SCE territory targeting one specific large single-story retailer that had large lighting displays that were retrofitted. Restaurants also had large operating hours, approximately 50% more than the average. Finally, small retail had operating hours about a quarter higher than average. The unit energy savings values are all highly correlated to the operating hours, and therefore will be lower for lodging, and higher for large single story retail, restaurants and small retail.

Based on these comparisons, the lodging segment is the lowest relative performer with the highest rate of free ridership and the lowest operating hours. This is also one of the largest participating segments, accounting for about a quarter of the CFLs overall and nearly 40% of the downstream CFLs. Targeting the specific large single-story retailer, which had large lighting displays that were retrofitted, was clearly a success, providing high operating hours and resulting energy savings. This model could be emulated for other large retailers with large lighting displays. Other market segments that could be targeted based on their operating hours are small retail and restaurants. Unfortunately, the retail segments exhibited low verification rates. Therefore, programs targeting these segments should utilize onsite inspections to ensure higher installation rates.

### 5.2.2 Comparison of Program Delivery Mechanisms

The programs that offered CFLs may be classified as upstream, downstream prescriptive rebate, or downstream direct installation programs. The following comparisons of results by program type provide some insight on the effectiveness of each delivery mechanism.

***Target Market.*** Although the upstream programs did not specifically target any market, participation was focused among assembly, lodging, small offices, restaurants, and small retail, which combined contributed to about 80% of all installations. The downstream programs, however, did appear to target lodging, which comprised nearly 40% of all downstream CFLs rebated. Furthermore, the downstream programs in PG&E and SCE territory targeted one specific large single-story retailer comprising 18% of the downstream CFLs rebated, which had large lighting displays that were retrofitted.

***Net-to-Gross.*** As with the linear fluorescent and high bay measures, free ridership was found to be significantly lower (about half) for the direct installation program than the downstream prescriptive rebate or upstream programs. Free ridership was only 25% for the direct installation program, 58% for the downstream prescriptive rebate program, and 47% for the upstream program.[1] One of the driving factors for the high free ridership in the downstream prescriptive rebate program is the lodging participants, which comprise nearly half of the savings and have a 66% free ridership rate.

***Verification Rates.*** Overall, verification rates were fairly similar, but slightly higher for direct installation programs. Verification rates were 80% for the direct installation program, 76% for the upstream program, and 72% for the downstream prescriptive program.

***Operating Hours and Unit Energy Savings.*** The operating hour analysis was combined for the two downstream programs, so comparisons can only be made between the upstream program and the combined downstream programs. As mentioned above, because there is a different distribution of how fixtures are installed by market segment for a given program, it is difficult to make a direct comparison at the statewide level. However, by examining operating hours at the segment level, it is clear that operating hours are generally higher for the upstream programs. Overall, operating hours are about a quarter higher for the upstream programs. Similarly, the unit energy savings values are also generally higher for the upstream programs.

As with the linear fluorescent measures, each program type has its strengths and weaknesses relative to the various net and gross impact parameters. The upstream program features higher operating hours and unit energy savings at the cost of higher free ridership. The direct installation program again features the lowest levels of free ridership and the highest verification rates, but with lower per unit energy savings. The downstream prescriptive program features the highest free ridership rates, the lowest verification rates, and lower unit energy savings values.

It should be noted, however, that the relatively poor performance of the downstream prescriptive program compared to the direct installation and upstream program is largely a result of the high participation in the lodging segment. This segment comprised roughly half the downstream prescriptive savings, had a free ridership rate of 66% within the downstream prescriptive programs, and had operating hours that were about a third of the average of the other market segments.

It is also important to note that the direct installation and upstream programs tend to focus more on the smaller customers (again which have lower free ridership and usually lower operating hours), whereas the downstream prescriptive rebate programs have historically been more successful reaching the larger customer population. Therefore, as long as it can

[1] Note that the upstream net-to-gross rates are reported in the Upstream Lighting Evaluation Report.

be shown that CFLs can be delivered cost-effectively through a downstream prescriptive rebate program, those programs still should be considered in an overall program portfolio. For example, as discussed above, the downstream programs in PG&E and SCE territory were very successful in targeting the large single-story retailer, which had large lighting displays that were retrofitted, and provided high unit energy savings.

## 5.3 Lessons Learned and Recommendations for Future Evaluation Efforts

Based on the lessons learned from this evaluation, the following recommendations are provided to guide future evaluation efforts. Recommendations are provided by analysis activity.

***Verification Analysis***

**Utilize on-sites**. Verification results for nonresidential lighting should be based on data collected on-site, which is much more reliable than data collected over the phone.

**Conduct on-sites soon after participation**. Verification on-sites should be conducted relatively soon after the customer installs the measure. Over time, lamps may fail and fixtures may burn out. Similarly, lamps initially placed in storage may be installed to replace burnouts. Finally, if there are discrepancies between program tracking data and what is found on site, customers are able to better recall what was installed and where.

***Installation of Lighting Loggers and Quality Control Issues***

**Work directly with a lighting logger manufacturer to develop better equipment**. There is a need to develop better time-of-use lighting logger equipment for monitoring outside lighting, lodging guest rooms, and down-lights.

**Thoroughly inspect lighting logger equipment before being used in the field**. This includes checking loggers for time drift (internal time clock is too fast or slow), magnets being securely attached to the logger, battery life being sufficient to last the length of the monitoring period, and the sensitivity of the logger to lighting sources.

**Conduct a pre-test**. Spend time up front to make sure that the study will produce the data required for the evaluation and then field test and revise the documents and procedures. Also, be prepared to make additional adjustments as the study continues to address significant issues as they are encountered.

**Take photos at the installation site**. It is imperative that photos be taken of the rooms in which loggers are placed so that the quality control analyst can see the conditions under which they are installed. This will help determine why a logger might have been flickering (e.g., if there were windows, if there was another light nearby, what type of room it was).

**Install redundant/backup loggers as matched pairs on the same circuit**. This allows for better identification of loggers with data collection issues and reduces the loss of valuable data by having a backup.

***Lighting Logger Recruitment for Pre-Post Studies***

**Provide an incentive to customers and vendors**. There were many challenges faced with recruiting participants for the pre-post lighting logger study. Recruitment was more successful when an incentive was paid to the customer as well as the lighting vendor (or direct installation contractor).

**Be responsive to vendor's installation schedule**. It was difficult convincing the lighting vendors to allow for a two-week period of pre-retrofit monitoring. Future evaluators should be aware that obtaining more than two weeks of pre-retrofit logger data may not be feasible. Therefore, it is important that the evaluator be extremely responsive when they are notified by the lighting vendor and install the logger equipment as soon as possible.

***Baseline Analysis***

**Utilize a dual baseline for linear fluorescents**. Most of the linear fluorescents rebated through the programs are early replacement, rather than a replacement on burnout. Therefore, future evaluations should consider a dual baseline for this measure, where the existing equipment is treated as the baseline for the remaining useful life of the replaced equipment. For years beyond the remaining useful life, through the measure's effective useful life, the baseline would be set equal to minimum code requirements.

**Collect baseline data to determine if baseline and post-retrofit usage differ**. This evaluation could not detect any significant differences between pre- and post-retrofit usage. However, this result was based on a limited amount of pre-retrofit period data for linear fluorescents and self-report data for CFLs. Future evaluations should attempt collecting baseline usage data and testing if pre- and post-retrofit usage is statistically significantly different or not, if possible.

**Do not use a constant ratio to estimate baseline wattage as a function of post-wattage for CFLs**. Baseline wattages were found to be correlated with the installed CFL wattages, but the relationship was found to be nonlinear. The ratio between baseline wattage and installed CFL wattage was found to decrease as the wattage of the CFL increased. Therefore, use caution in estimating baseline wattage as a constant ratio of CFL wattage as this may not be accurate for relatively high or relatively low wattage CFLs.

***Lighting Logger Analysis***

**Do not aggregate operating hour analysis across different program delivery mechanisms**. Program delivery mechanisms were found to result in different estimates of annual hours of use, even within a market segment and activity area. Therefore, if analysis is being done across a variety of programs with various delivery mechanisms (e.g., upstream, downstream prescriptive, or direct installation), it is important to compare intermediate results by program type, market segment and activity area to determine if analysis can be combined across program types, or if it needs to be performed by program type.

**Rely on spot watt measurements, not manufacturer rated wattages, for pre-retrofit linear fluorescent measures**. Manufacturer data on fixture wattages for linear fluorescent measures were found to be very reliable for post-retrofit measures, as the manufacturer data matched very well with spot watt measurements. However, manufacturer data for linear fluorescent measures were not believed to be reliable for pre-retrofit measures. Therefore, pre-retrofit wattage estimates should rely on spot watt measurements whenever possible.

**Lighting logger data collection should be representative of all seasons of the year to determine the affects of daylight on usage.** For this evaluation, only one to two months of post-retrofit data were collected and then extrapolated out to annual 8760 hourly load shapes. Analysis was conducted to determine if there were any affects of daylight on usage over the course of the year that would affect the hourly load shapes over time. Although no statistically significant affect was found, future evaluation efforts should continue to test this hypothesis to determine if daylighting changes over the course of the year should be incorporated into any 8760 extrapolation. It is important to ensure that the lighting logger sample is representative of all periods over the course of the year to accurately account for this potential affect.

***Billing Analysis***

**Require program implementers to record installation dates for when rebated measures are installed**. Program implementers need to provide more accurate installation dates for rebated measures to support the billing analysis. Quite often, no installation date was provided for this evaluation. If program implementers do not provide an installation date, the phone survey should attempt to gather this information.

**Require program implementers to record all meters impacted by installed measures.** Program implementers should record all of the meters impacted by the retrofit instead of just one meter. Improved tracking of the meters impacted by the retrofit would ensure that the site aggregation for billing data was correct, eliminating much of the uncertainty of the process.

***Net-to-Gross Analysis***

**Define the analysis approach early on**. It is important to establish the net-to-gross approach early in the research process to ensure the telephone survey questionnaire collects all necessary data, and allow for thorough testing of the approach before full implementation of the survey.

**Identify all incentives and types of assistance participants are provided.** The evaluator should be aware of all the different types of assistance that a customer may have received (e.g., technical assessment, incentive level, etc.), so that all aspects of the program influence can be incorporated into the net-to-gross approach

**Conduct surveys in waves soon after participation**. Surveys should be conducted relatively soon after participating, ideally no later than six months after participation. This will drastically improve customer recall. This may require that waves of surveys be performed on an ongoing basis. It is of great value to program implementers to receive interim results on an ongoing basis in order to enable implementers to make program design changes that address net-to-gross issues.

**Conduct on-site visits with nonparticipants when conducting discrete choice analysis**. As part of the discrete choice analysis, nonparticipants are surveyed in order to gather information about lighting changes that were made outside of the program. It is important to validate the efficiency of the equipment they reported installing to reduce any potential bias in the self-report response about efficiency. Performing on-site visits with nonparticipants that reported an installation outside the program is the most accurate way of validating their responses.

***Program Implementation Issues***

**Improve measure names and codes**. Measure names should be more consistent across programs and utilities and, ideally, a consistent set of measure codes should be used. For prescriptive measures, the IOU rebate applications typically include an alphanumeric identifier as well as a brief measure description. However, some of the tracking databases did not include the measure code and the measure descriptions for the same measure were not identical (extra spaces, misspelled, etc.). Using the measure code will eliminate these issues. Also, measure codes should line up with the codes on the rebate forms and/or work paper documentations or procedures. Finally, measures should only be allowed to use one unique “unit basis” for each code (e.g., lamps).

**Document baseline conditions**. It is important to provide some level of information on the equipment that was replaced. At a minimum, this could be incorporated into the measure description.

**Collect business hours on rebate applications.** While not always an accurate indicator of equipment operation, it would be useful for validating lighting logger data and can be used as a variable for ratio estimation or regression analysis to help predict operating hours and improve the accuracy of that estimation process.

**Use building types that are consistent with DEER**. Utility program tracking systems should include a building type identifier that is consistent with DEER, developed from a combination of information collected on the rebate application and NAICS information from the customer information systems (CIS).

# Glossary of Acronyms

| | |
|---|---|
| AC | Air Conditioning |
| AMBAG | Association of Monterey Bay Area Governments |
| CATI | Computer Aided Telephone Interview |
| CBO | Community-Based Organizations |
| CFL | Compact Fluorescent Light |
| CIS | Customer Information System |
| CPUC | California Public Utilities Commission, the sponsor of the evaluation. |
| DEER | Database for Energy Efficient Resources. A California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source. DEER has been has been designated by the CPUC as its source for deemed and impact costs for program planning. |
| ED | Energy Division of the CPUC |
| EM&V | Evaluation Measurement, Monitoring and Verification |
| ERT | Evaluation Reporting Tool |
| FBO | Faith-Based Organizations |
| FEW | Fresno Energy Watch |
| FR | Free Ridership |
| HE | High Efficiency |
| HVAC | Heating Ventilation Air Conditioning. End-use classification for mechanical equipment that is used to condition spaces in commercial and industrial facilities. |
| HIM | High Impact Measure. A relatively small group of measure and program combinations that account for the majority of utility reported annual energy and demand savings during 2006 and 2008 program cycle. |
| IOU | Investor-owned utilities, which include Pacific Gas and Electric (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), and San Diego Gas and Electric (SDG&E). |
| kW | Kilowatt |

| | |
|---|---|
| kWh | Kilowatt hour |
| MECT | Master Evaluation Contractor Team. A group of consultants with specialized expertise in important aspects of program impact evaluation that are advisors to ED staff and assist the evaluation contractors with development and execution of the verification and evaluation plans. |
| MPS | As part of the Shareholder Incentive Mechanism, the minimum performance standard is the minimum level of savings that utilities must achieve relative to their savings goal before accruing earnings and is expressed as a percentage of the Commission-adopted savings goals per utility. |
| NL | Nested Logit |
| NRDI | Nonresidential Direct Install |
| NTGR | Net-to-Gross Ratio. A ratio or percentage of net program impacts divided by gross or total impacts. Net to gross ratios are used to estimate and describe the free-ridership that may be occurring within energy efficiency programs. |
| PG&E | Pacific Gas & Electric Company |
| P/NP | Participant/Nonparticipant |
| POC | Point of Control |
| SBSS | Small Business Super Saver |
| SCCG | Small Commercial Contract Group |
| SCE | Southern California Edison Company |
| SCG | Southern California Gas Company |
| SDG&E | San Diego Gas & Electric Company |
| SRA | Self-Report Approach |
| TOU | Time of Use |
| UES | Unit Energy Savings |