Energy Efficiency Portfolio Report

CALIFORNIA PUBLIC UTILITIES COMMISSION

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Tables & Figures

Acronyms

C & S	Codes and Standards
CCA	Community Choice Aggregator
CEC	California Energy Commission
CLEESP	California Long-Term Energy Efficiency Strategic Plan (Strategic Plan)
CO2	Carbon Dioxide
CPUC	California Public Utilities Commission
EMT	Energy Management Technology
EUC	Energy Upgrade California
ETP	Emerging Technologies Program
EM&V	Evaluation, Measurement, and Verification
GWh	Gigawatt-hours
HVAC	Heating, Ventilation, Air Conditioning
IDSM	Integrated Demand Side Management
IOU	Investor-owned utility
MCE	Marin Clean Energy
ME&O	Marketing, Education, & Outreach
MMBTU	Million British Thermal Units
NTGR	Net to Gross Ratio
NOx	Nitrogen Oxide
PA	Program administrator
PIP	Program Implementation Plan
PG&E	Pacific Gas & Electric
REN	Regional Energy Network
SCE	Southern California Edison
SCG	Southern California Gas Company
SDG&E	San Diego Gas & Electric
SEM	Strategic Energy Management
TRC	Total Resource Cost
ZNE	Zero Net Energy

Executive Summary

Scope of California's Energy Efficiency Programs

The California Public Utilities Commission's (CPUC) Energy Efficiency Portfolio Report summarizes the achievements of California's energy efficiency programs implemented from the start of 2013 through 2015. These programs help California become more energy efficient by reducing electricity and natural gas consumption while collectively resulting in significant reductions to California's greenhouse gas emissions.

Energy savings were measured through more than 100 evaluation studies conducted across the set of more than 400 programs that constituted the 2013-2015 energy efficiency program portfolio. These studies verified the energy savings and accurately measured the progress toward meeting state energy efficiency and climate goals. The success of energy efficiency programs affects the future need for additional power plants and related energy infrastructure. Accurate measurement of the savings impact of California's energy efficiency programs, through these evaluation studies, is therefore of critical importance to planning California's energy future. Impact evaluations of programs take place after the program year of interest has concluded. These evaluation studies can take a year or more to complete, with additional time needed for data processing. The CPUC thus received data from the last of the 2015 impact evaluations in mid-2017. Compilation and analysis of the full program cycle data set, along with writing itself, were then conducted to produce this report.

While the CPUC provides direction and oversight for the energy efficiency programs, the programs themselves are implemented and administered by program administrators (PAs). Program administrators in the 2013-2015 energy efficiency portfolio included the four major investor-owned utilities (IOUs): Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Southern California Gas Company (SCG), and San Diego Gas & Electric (SDG&E), as well as two regional energy networks, BayREN and SoCalREN, and one community choice aggregator, Marin Clean Energy (MCE).

The 2013-2015 portfolio cycle is the last cycle to follow the 3-year program cycle structure. In 2013, the CPUC issued the "Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues." The Rolling Portfolio framework is envisioned as a long-term (e.g. 10-year) authorization and planning framework for energy efficiency programs after 2015. The CPUC is currently in the process of implementing this new framework.

Portfolio Impacts and Success of the 2013-2015 Energy Efficiency Programs

The CPUC considers a portfolio successful if the program meets the energy savings goals set at the beginning of the program and is cost-effective. The effectiveness of the energy efficiency portfolio is measured via four distinct metrics (corresponding units in parentheses):

- energy savings (electricity in GWh and natural gas in MM therms)
- peak electricity demand savings (MW)
- emissions savings (tons of CO2 and tons of NOx)
- Cost-effectiveness (overall dollar savings of from the program exceeds the program costs)

Throughout this document, there is a distinction made between "net" and "gross" savings. This distinction refers to the fact that some program incentives are provided to customers who would have adopted the

energy efficiency equipment or practice even without at utility program. The gross savings estimate includes these so-called free riders (i.e., gross savings estimates simply represent the estimated savings per EE widget times the number of rebates provided for the EE widget), whereas the net savings estimates back out savings attributed to these free riders to determine what savings occurred as a result of the EE program's existence. The discussion of energy savings at the portfolio level focuses on evaluated gross savings because the 2013-2015 portfolio goals were set for evaluated gross savings. In individual sector or program chapters, however, the default savings values discussed are evaluated net savings, in order to focus the discussion on the savings that occurred as a direct result of program impacts and because cost-effectiveness is calculated based on net savings.

Table ES-1: Energy Efficiency Savings Goals

2013-2015 Energy Efficiency Portfolio Goals

		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Program Goals	**Gross**	4,410	830	130
Codes and Standards Goals		1,756	243	7
Combined Goals		6,166	1,073	137

For the 2013-2015 portfolio, the CPUC goals for the energy efficiency program were a reduction in electricity usage of 4,410 GWh and 130MMtherms in gas usage. The CPUC allowed program administrators to include low-income program savings in their goal attainment numbers, but established separate codes and standards savings goals.[1] Table ES-1 shows the breakdown of savings goals for the program portfolio and codes and standards. The combined goals are shown for illustrative purposes only.

The 2013-2015 Energy Efficiency Portfolio surpassed electricity savings goals while staying within budget

The 2013-2015 energy efficiency programs served an important role in California's energy sector, providing large amounts of evaluated and verified energy savings and, by extension, avoiding large quantities of greenhouse gases and particulate emissions. These programs achieved all of this while staying within the allocated 3-year budget for the portfolio ($2.6 billion in expenditures out of a budget of $2.7 billion).

The energy and emissions savings accrued by the portfolio over the 3-year program cycle are shown in Table ES-2. The realization rate is the ratio of evaluated savings to savings reported (pre-evaluation) by the Program Administrator. It is an important metric in determining the accuracy of reporting and energy savings estimates.

[1] Decision 12-11-015, "Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach" Date of Issuance: 18 May 2012, p.87

Table ES-2: 2013-2015 Energy Efficiency Programs Energy and Emissions Savings [1]

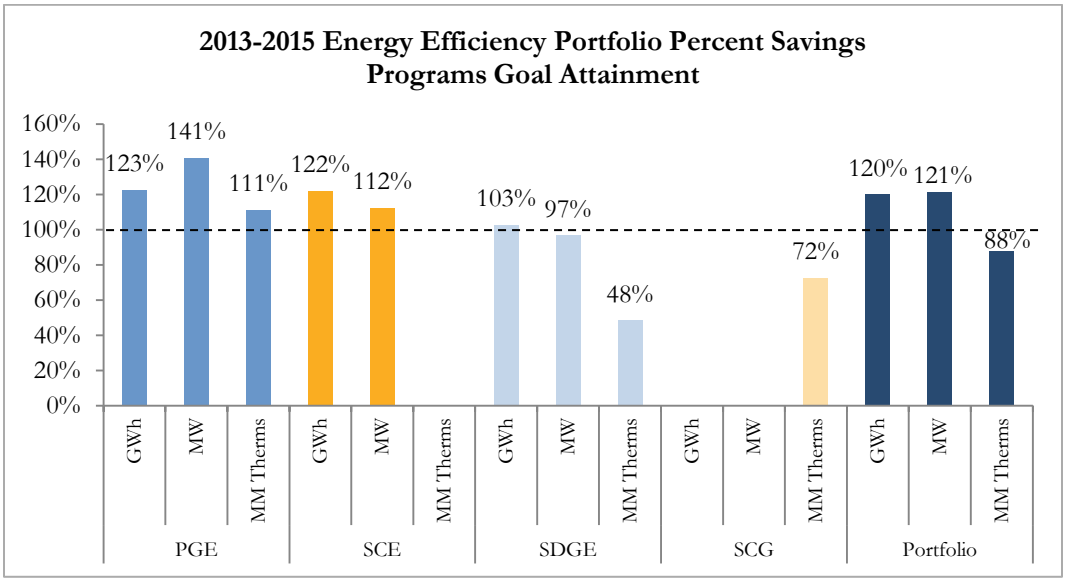
		Energy Savings			Emissions [2]	
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 Pounds)
Goals	**Gross**	4,410	830	130		
Evaluated Portfolio Savings	**Gross**	5,070	954	100	7,053	2,607
	Net	3,230	624	67	4,102	1,568
Realization Rate [3]	**Gross**	93%	94%	76%		
	Net	83%	87%	75%		
Codes & Standards Savings[4]	**Gross**	12,282	2,267	93		
	Net	3,597	546	39		

(1) First-year savings. Program savings do not include low-income savings or Codes & Standards savings. Program savings are used to calculate cost-effectiveness and to calculate emissions savings.
(2) Emissions are not calculated for low-income programs or Codes and Standards savings
(3) Realization rate describes the ratio of evaluated savings to savings reported (pre-evaluation) by the Program Administrator.
(4) See the Codes & Standards chapter for more information on Codes & Standards savings and programs

The 2013-2015 energy efficiency portfolio surpassed the electricity savings goals set by the CPUC, as shown in Figure ES-1. The 2013-2015 energy efficiency program portfolio saved 5,070 gigawatt-hours of electricity, 954 megawatts of demand, and 100 million therms of natural gas, exclusive of the savings attributed to the codes & standards and low-income programs. These savings are equivalent to avoiding the annual electricity consumption of over 790,000 average California residences and the annual natural gas consumption of over 323,000 average California homes.

The Commercial customer sector surpassed the Residential sector as the largest share of electric savings, compared to the 2010-2012 energy efficiency portfolio. This shift is mostly due to the successful market adoption of efficient lighting in the Residential sector. As market adoption grows, the available savings for lighting measures in the Residential sector decrease.

Figure ES-1: 2013-2015 Energy Efficiency Goal Attainment by IOU



For the 2013-2015 program cycle, the CPUC allowed PAs to include low-Income program savings in the goal attainment calculation. The above chart is based on evaluated gross savings includes REN and CCA savings within their respective IOU counterpart count and low-income savings. Codes and Standards savings are not included in this chart.

Natural gas savings achieved 88 percent of their CPUC-set savings goals for the portfolio. In keeping with past trends, the industrial customer sector contributed the largest share of natural gas savings throughout the program cycle.

The program administrators exceeded their program savings goals for electric savings and peak demand savings (120 percent and 121 percent, respectively), and came close to the natural gas savings goal (88 percent).[2] Codes and Standards savings greatly exceeded goals. Electric codes and standards savings achieved 223 percent of the gigawatt-hour savings goal and 237 percent of the peak demand savings goal, while natural gas savings were 186 percent of the codes and standards savings goal. Codes and Standards savings are shown in Table ES-2.

In addition to determining the total savings achieved, evaluation studies also calculate how much of these savings can be directly attributed to program interventions, rather than other factors such as normal market adoption. Evaluations of the 2013-2015 program cycle determined that CPUC energy efficiency programs were the driving force behind California's energy savings. Two-thirds of the energy savings achieved during the 2013-2015 period can be tied directly to the energy efficiency programs implemented by program administrators.[3]

[2] See Appendix A for further information on Goal Attainment calculations and a breakdown of goals and savings by program administrator.
[3] This calculation is known as the net-to-gross ratio and is explained further in the glossary.

The evaluated Energy Efficiency Portfolio was not cost-effective for the 2013-2015 program cycle

In addition to energy savings goals, the portfolio is evaluated for its cost-effectiveness. The cost effectiveness of the portfolio is evaluated using two different cost-effectiveness tests: the Total Resource Cost (TRC) and Program Administrator Cost (PAC) tests (together, the "the dual test").The TRC equation divides the dollars saved from energy efficiency by the costs incurred by both the PA (IOU, REN, or CCA) and the program participants (customers), combined. Generally, activities that pass the TRC test will pass the PAC test, making TRC the de facto test of portfolio cost effectiveness.

The combined portfolio for all program administrators, excluding Codes & Standards, as measured by Total Resource Cost test (TRC), was 1.17 in 2013, 0.99 in 2014, and 0.78 in 2015, as shown in Table ES-3.[4] The evaluated portfolio TRC for the three year (2013-2015) period was 0.87. Some reduction in cost – effectiveness was expected in 2015 as the program administrators began preparing for the new Rolling Portfolio framework that is currently in the process of being implemented. As program administrators transition to this new framework, it is expected to see positive cost-effectiveness impacts.

Table ES-3: Total Resource Cost by Year

Cost-effectiveness (Total Resource Cost) 2013-2015 Energy Efficiency Programs				
	2013	**2014**	**2015**	**13-15 Program Cycle**
Evaluated Portfolio TRC	1.17	0.99	0.78	0.87

As noted previously, the CPUC does not include codes and standards savings or costs when determining portfolio cost-effectiveness. Cost-effectiveness is calculated separately for the C&S programs and is consistently very high. As noted in the guidance decision for this program cycle, the CPUC separated C&S from the other programs in order to, "avoid the risk of overemphasis on codes and standards advocacy at the expense of the utility programs that are needed to ensure technologies and building practices are available and affordable as they become required by code."[5]

[4] An evaluated TRC score of 1.0 or higher indicates a portfolio is cost effective, while a score lower than 1.0 indicates a portfolio is not cost effective.
[5] "Goals Proposal," Attachment A of 2013-2014 Energy Efficiency Goals Ruling at 9.

Introduction

Scope of this Report

The CPUC's Energy Efficiency Portfolio Report summarizes the achievements of the CPUC's 2013-2015 energy efficiency programs, based on evaluation studies fielded during and after the three-year program cycle. These programs help California become more energy efficient by reducing electricity and natural gas consumption while, collectively, resulting in significant reductions in California's greenhouse gas emissions. The CPUC's energy efficiency programs span a variety of economic sectors, encompassing residential homes and commercial buildings, large and small appliances, lighting and HVAC end uses, industrial customers, manufacturers, and agriculture. Within those sectors, efficiency programs achieve energy savings using a number of different tools: financial incentives and rebates, research and development for energy efficiency technologies, financing mechanisms, building codes and appliance standards development, and education and public outreach.

The original guiding document for these programs is known as the California Long Term Energy Efficiency Strategic Plan. This comprehensive plan is the state's integrated framework of goals and strategies for saving energy, covering government, utility, and private sector actions, and holds energy efficiency to its role as the highest priority resource in meeting California's energy needs.[6]

Program administrators (PA) operate the energy efficiency programs ordered by the CPUC. PAs include the IOU, regional energy networks (REN), and community choice aggregators (CCA).[7] The PAs are responsible for implementing energy efficiency programs while the CPUC is responsible for guiding, overseeing, and evaluating these activities to inform future policy direction, improve program design, and refine savings estimates.

Specific guidance for the implementation of the 2013-2015 portfolio was administered to program administrators through several CPUC decisions:

- D.12-05-015, "Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach" (Proceeding R.09-11-014);
- D. 12-11-015, "Approving 2013-2014 Energy Efficiency Programs and Budgets" (Proceeding A1207001; A1207002; A1207003; A1207004);
- D.14-10-046, "Decision Establishing Energy Efficiency Savings Goals and Approving 2015 Energy Efficiency Programs and Budgets" (Proceeding R.13-11-005)

The Energy Efficiency Portfolio Report complies with Public Utilities Code section 913.5.[8] The CPUC issued the last iteration of the Energy Efficiency Portfolio Report on March 2015 and summarized the 2010 – 2012 portfolio cycle. This report is based on the studies from the 2013-2015 portfolio cycle.

[6] The California Long Term Energy Efficiency Strategic Plan can be accessed here: http://www.cpuc.ca.gov/General.aspx?id=4125
[7] While the investor-owned utilities implement the bulk of energy efficiency programs statewide, the 2013-2015 portfolio cycle saw the introduction of two new types of program administrators: regional energy networks and community choice aggregators.
[8] Public Utilities Code 913.5: The CPUC shall submit a report to the Legislature by July 15, 2009, and triennially thereafter, on the energy efficiency and conservation programs it oversees. The report shall include information regarding authorized utility budgets and

This report synthesizes and highlights the results from more than 100 evaluation studies conducted across a set of more than 400 programs that constituted the 2013-2015 energy efficiency program portfolio. These evaluation activities reviewed 65 percent of reported savings. Given the summary nature of this report, readers are encouraged to return to the original source documents for a more comprehensive treatment of the material summarized here, if interested in a particular sector or program area. The report provides references to the original research described within and a list of impact evaluations is included in the appendices.

Organization of this Report

The report is organized into chapters that focus either on a customer sector (residential, commercial, industrial, and agriculture) or on a crosscutting topic area (e.g. Codes and Standards, Lighting, HVAC) that comprises an important program area. The inclusion of crosscutting topics as distinct chapters means that it would be incorrect to sum the energy savings listed in each chapter to get the total portfolio savings. Each chapter is simply a different view of a subset of the evaluation data. For instance, lighting programs' energy savings are addressed in their own chapter, although the savings from these end uses are included in relevant customer sectors to show the contribution to lighting savings in that customer group. For synthesis of how various sectors and end-uses affected the portfolio-level savings, please refer to the Overview sections below or the Appendices.

The appendices to this report provide the detailed summaries of accomplishments by program administrator, program, sector, and measure group. Detailed data on cost-effectiveness and emissions reductions impacts are also provided in these appendices.

Evaluation Methodology and Terminology

The five evaluation, measurement, and verification (EM&V) research objectives for the portfolio are:

1. Savings Measurement and Verification
2. Program Evaluation
3. Market Assessment
4. Policy and Planning Support
5. Financial and Management Audits

These objectives are accomplished through three types of evaluation studies:

- **Impact Evaluations** measure program impacts, estimating net changes in electricity usage, electricity demand, usage of natural gas, and/or behavioral impacts that are expected to produce changes in energy use.[9]
- **Process Evaluations** are systematic assessments of energy efficiency programs, products or services for the purposes of identifying and recommending improvements that can be made to the program.[10]

expenditures and projected and actual energy savings over the program cycle. (Added by renumbering Section 913.7 by Stats. 2016, Ch. 842, Sec. 26. Effective January 1, 2017.)

[9] California Public Utilities Commission, *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*, April 2006 p.19

[10] op. cit. note 9, p. 131

- **Market Studies** gauge current market situations that inform savings baselines, identify and track appropriate baseline metrics of market change, measure progress toward achieving long-term Strategic Plan objectives, and inform estimates of remaining potential for energy efficiency.

Savings reported by the program administrators are evaluated and verified. Evaluated savings may differ from reported savings because of a number of different factors including, the energy efficiency measure not being installed properly, the use of incorrect hours of operation, or the use of incorrect baseline assumptions for the reported values. In the 2013-2015 portfolio cycle, 69 percent of reported gross electricity savings and 68 percent of gross natural gas savings received some form of field evaluation. For the reported savings that are not evaluated, the reported savings may be determined to be pass-through values using IOU-reported savings. [11]

Savings are reported as both gross savings and net savings. Gross savings are the savings, in total, that occurred in a sector, program area, or portfolio. Net savings are the savings that are directly applicable to program interventions, as in they would not have occurred if the program had not been implemented. The difference between net and gross is attributed to free ridership, which describes savings that would have occurred without program intervention.

A Note on the Numbers:

This report contains data on both the reported and evaluated, as well as gross and net, savings values. While the reported savings are contained within tables and the appendices, any portfolio-level analysis in the following chapters (e.g. percentage of portfolio calculations) is based on evaluated net savings values, except where explicitly stated. The discussion of savings at the portfolio level focuses on evaluated gross savings because the 2013-2015 portfolio goals were set for evaluated gross savings. Therefore, Staff compares evaluated gross savings at the portfolio level to the evaluated gross savings goals. In individual sector or program chapters, however, the default savings values discussed are evaluated net savings, in order to focus the discussion on the savings that occurred as a direct result of program impacts.

Additionally, all savings data in tables or figures are first-year savings, inclusive of REN and CCA savings and exclusive of codes and standards savings, except where explicitly stated. First-year savings are the savings that a measure accrues in the first year after installation, as opposed to lifecycle savings that accrue over the entire lifetime of the equipment or measure that was installed. Lifecycle savings are used in cost effectiveness calculations.

All savings and expenditures data are sourced from the 2013-2015 evaluation data, prepared by Itron and based on the results from all program evaluations.

[11] Claimed savings may not be evaluated as they are determined to be pass through values, or accepted claims that do not fall within the frame of an impact evaluation or may not evaluated due to resource or time constraints on evaluators.

2013-2015 Portfolio Overview

Goals and Overview of 2013-2015 Portfolio Activities

Based on CPUC direction for the 2013-2015 portfolio, the portfolio is considered successful if it is cost-effective and meets all of the CPUC's savings goals. Savings goals are set via CPUC decision, based on the Energy Efficiency Potential and Goals study. [12,13] Goals were set for electric savings (expressed in gigawatt-hours or GWh), peak megawatt load reductions (also called demand savings and expressed in megawatts or MW), and natural gas savings (expressed in millions of therms or MM Therms). As previously noted, the 2013-2015 savings goals were set for gross savings, not net savings. Consequently, each IOU's gross (evaluated) savings achievements were compared to the CPUC's goals to determine portfolio success. The CPUC-adopted 2013-2015 savings goals for each IOU territory are provided in Table 1 below. In Decision 12-05-015, the CPUC directed that codes and standards goals be separated from the program goals. This is a distinct change from the 2010-12 program cycle in which IOUs could credit codes and standards advocacy savings toward their energy efficiency goals.[14]

Table 1: 2013-2015 IOU Program Goals

	2013-2015 Goals by Investor-Owned Utility		
	Electric (GWh)	**Demand (MW)**	**Natural Gas (MM Therms)**
PGE	1,889	324	56
SCE	2,030	408	-
SDGE	492	98	7
SCG	-	-	68
Total Portfolio	**4,410**	**830**	**130**

In addition to achieving the savings goals, each IOU must reach their savings goals in a cost-effective manner. As clarified in D.09-09-047, the cost effectiveness of the portfolio is evaluated using two different cost-effectiveness tests: the Total Resource Cost (TRC) and Program Administrator Cost (PAC) tests (together, the "the dual test").The TRC equation divides the dollar benefits gained from energy efficiency by the costs incurred by both the PAs and the program participants, combined.[15] Generally, activities that pass the TRC test will pass the PAC test, making TRC the de facto test of portfolio cost effectiveness. Cost-effectiveness

[12] D.12-05-015, "Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach" Date of Issuance: 18 May 2012, p.95;
D.14-10-046, "Decision Establishing Energy Efficiency Savings Goals and Approving 2015 Energy Efficiency Programs and Budgets," Date of Issuance: 24 October 2014, p.10
[13] Navigant Consulting, Inc. *Analysis to Update Energy Efficiency Potential, Goals, and Targets for 2013 and Beyond*. 19 March 2012. Available at: http://www.cpuc.ca.gov/General.aspx?id=6442452622
[14] Decision 12-11-015, "Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach" Date of Issuance: 18 May 2012, p.87
[15] Since incentives are paid by Program Administrators to participants, participant incentive payments net to zero in the TRC, while the PAC test includes all Program Administrator costs (including all incentive payments) but excludes customer costs (i.e., any out of pocket costs beyond the incentive for more expensive efficiency equipment)

calculations use net savings in the numerator, and remove "free rider" incentive payments out of the denominator, to measure the costs of the program against the estimated impacts of the program.[16]

In the guidance for the 2013 and 2014 programs, the CPUC set the requirement that each IOU's portfolio needed to achieve a TRC ratio of at least 1.25, independent of the costs and benefits of the REN, spillover effects, and Codes and Standards program costs and benefits. In D.14-10-046, which established guidance for the 2015 energy efficiency programs, the CPUC modified the cost-effectiveness threshold to 1.0 for the PAC and TRC for 2015, in order to accommodate a transition period into a new regulatory framework for energy efficiency programs, known as the Rolling Portfolio.

The IOUs are accountable for achieving the total portfolio goals defined by the CPUC in Decision 12-05-015 and for ensuring that the portfolio is cost-effective, according to the guidance in Decision 12-11-015. However, the IOUs' success is measured at the portfolio level, giving the program administrators the flexibility at the sector or program level to include activities that may not, by themselves, be cost-effective.

In addition to programs and activities that directly generate energy savings, the IOUs support complementary programs that address long-term market transformation. Known as non-resource programs, these programs represent energy efficiency activities that do not focus on displacement of supply-side resources at the time they are implemented, but may lead to displacement over the longer-term or may enhance program participation overall. Non-resource programs do not provide direct energy savings, but do add costs to the portfolio, making them not cost-effective on their own. However, non-resource programs frequently provide necessary support to resource programs.

The CPUC authorized $2.7 billion in ratepayer-funded energy efficiency programs for the 2013-2015 program cycle. The PAs spent $2.6 billion of that authorized amount over the three-year cycle.[17]

Impacts of the 2013-2015 Energy Efficiency Portfolio

The impact of the energy efficiency portfolio is measured via four distinct metrics (corresponding units in parentheses):

- energy savings (electricity in GWh and natural gas in MM Therms)
- peak electricity demand savings (MW)
- emissions savings (tons of CO2 and tons of NOx)
- cost-effectiveness (total resource cost)

[16] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and* Projects. October 2001, p. 18. TRC equals the net present value of the avoided costs of the supply-side resources avoided divided by the net present value of the net costs to participants for installed measures over the measure life, plus all costs incurred by the program administrator. The net benefits and net participant costs excluded the benefits derived from and costs paid by free-rider participants.

[17] Unspent funds are allocated to subsequent program cycle funding requirements. See D.12-11-015, section 6.1 "Treatment of Unspent Funds from Prior Portfolio Cycles" for details.

Table 2: Savings, Emissions, and Cost-Effectiveness of 2013-2015 Portfolio

Energy and Emission Savings from 2013-2015 Energy Efficiency Programs [1]							
		Energy Savings			Emissions [2]		Cost Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 Pounds)	TRC
Goals	**Gross**	4,410	830	130			
Reported	**Gross**	5,430	1,007	132			
	Net	3,877	719	89			1.15
Evaluated	**Gross**	5,070	954	100	7,053	2,607	
	Net	3,230	624	67	4,102	1,568	0.87

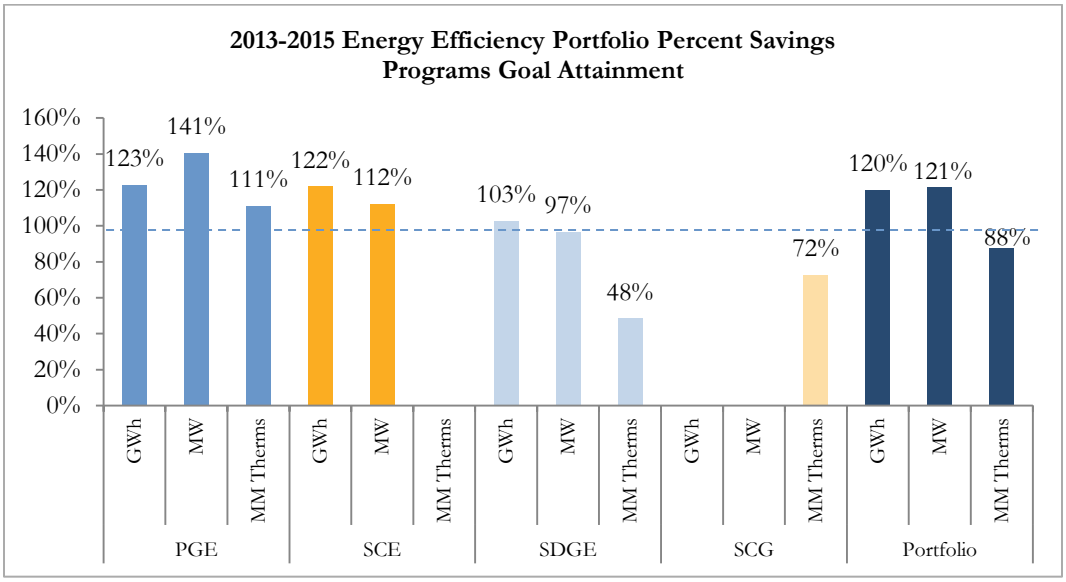
Table Notes: (1) First-Year Savings. Includes RENs and CCAs savings, Codes & Standards advocacy savings, and low-income program savings. (3) Program savings do not include low-income savings or Codes & Standards savings, but do include RENs and CCA savings. Program savings are used to calculate cost-effectiveness and to calculate emissions savings. (2) Emissions are not calculated for low-income programs or Codes and Standards savings.

At the statewide portfolio level, the 2013-2015 energy efficiency portfolio saved 5,070 gigawatt-hours of electricity, 954 megawatts of demand, and 100 million therms of natural gas, exclusive of the savings attributed to the codes & standards program and low-income programs, as shown in Table 2.[18] These savings are equivalent to avoiding the annual electricity consumption of over 790,000 average California residences and the annual natural gas consumption of over 323,000 average California homes.[19]

When considering just these program impacts, the energy efficiency portfolio already exceeded most of its savings goals. The 5,070 gigawatt-hours of savings exceeded the electricity savings goal for the statewide portfolio by 20 percent. Peak demand savings for the statewide portfolio also exceeded its goals, achieving 954 MW saved or 9 percent above the statewide goal. The evaluated gross natural gas savings achieved 88 percent of the statewide goals, however, delivering 100 MM therms out of a goal of 130 MM therms of savings.

[18] Codes & Standards savings are tracked separately from the customer-targeted programs savings and goals. Codes & Standards have their own set of goals, for which further detail can be found in the Codes & Standards chapter.
[19] Equivalent homes were calculated using data from the U.S Energy Information Administration. Average California household electricity consumption for 2015 equals 6,684 kwh. Total annual residential natural gas consumption in California in 2015 equaled 401,172 million cubic feet of gas while the Census Bureau reports California had 12,700,000 households in 2015.
Avg. Electricity Consumption: https://www.eia.gov/tools/faqs/faq.php?id=97&t=3
Natural Gas Consumption: https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_sca_a.htm
Number of Households: https://www.census.gov/quickfacts/CA

Figure 1: 2013-2015 Energy Efficiency Goal Attainment by IOU



For the 2013-2015 program cycle, the CPUC allowed PAs to include low-Income program savings in the goal attainment calculation. The above chart is based on evaluated gross savings includes REN and CCA savings within their respective IOU counterpart count and low-income savings. Codes and Standards savings are not included in this chart.

For the 2013-2015 portfolio, however, the CPUC allowed program administrators to include low-income program savings in their goal attainment numbers. When inclusive of these program savings, the goal attainment percentages reach 120 percent, 121 percent, and 88 percent for electric savings, demand savings, and natural gas savings, respectively. Figure 1 shows the percent goal attainment by IOU while Table 3 below shows the goals values.

Table 3: Goals for the 2013-2015 Portfolio

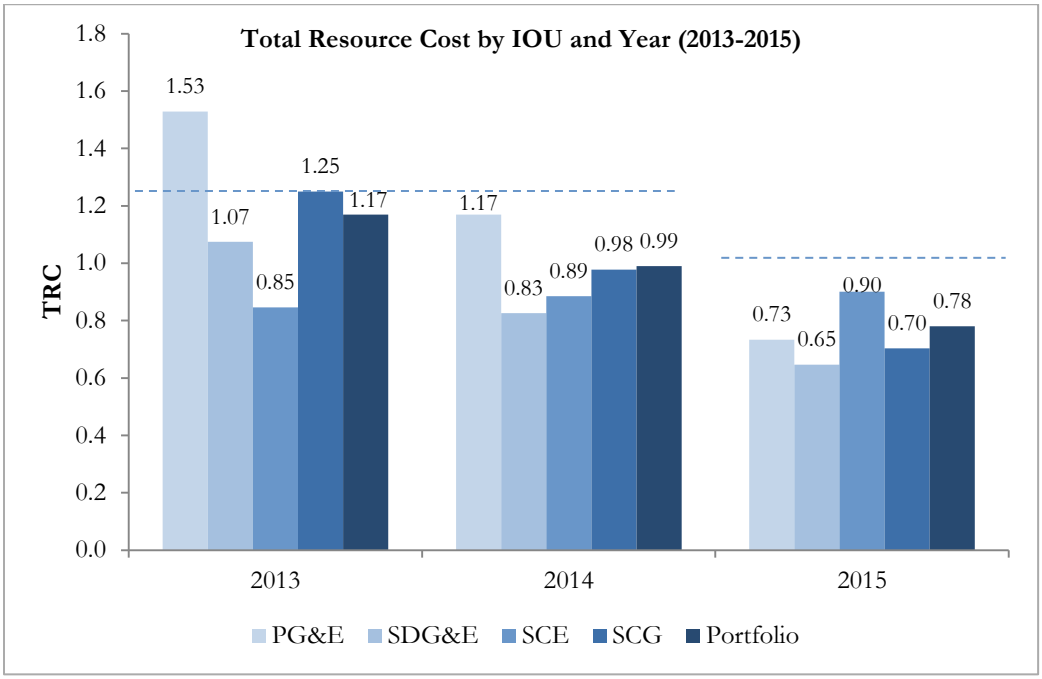
2013-2015 Energy Efficiency Portfolio Goals				
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Program Goals	**Gross**	4,410	830	130
Codes and Standards Goals		1,756	243	7
Combined Goals		6,166	1,073	137

Excluding Codes & Standards costs and benefits, the statewide portfolio's evaluated savings fell short of its cost-effectiveness goal of a 1.25 TRC in 2013 and 2014 and its goal of a 1.0 TRC in 2015.

2 below shows the annual cost-effectiveness ratios of each IOU portfolio. The only year in which any of the IOUs met their cost-effectiveness goals was 2013. PG&E and SCG both managed to meet or exceed the 1.25 TRC threshold in in 2013, but then fell below 1.25 in 2014 and below 1.0 TRC in 2015. SCG and SDG&E

came in below the TRC thresholds in each year. One factor that contributes to lower cost-effectiveness is accounting for energy efficiency activities that would have occurred absent program intervention.

Figure 2: Annual IOU Portfolio Cost Effectiveness Ratios (2013-2015)



The blue dotted lines in the chart above show the TRC threshold of 1.25 (2013 and 2014) and 1.0 (2015) that were set by the CPUC via decision. Program savings used for this calculation do not include Codes & Standards savings.

Cost-effectiveness of the entire portfolio increases, however, if one considers the costs and benefits of the Codes & Standards programs combined with the above portfolio cost-effectiveness. The Codes & Standards program has been discussed in past decisions as a potential hedge against failure to meet savings goals or cost-effectiveness targets given that C&S advocacy reliably produces savings year over year in a significantly cost-effective manner. While the decision to separate C&S savings and program savings is discussed at length in D.12-05-015 (page 87), the impact of C&S savings on portfolio cost-effectiveness is discussed below for illustrative purposes.

Codes & Standards Savings

The Codes and Standards (C&S) program saves energy by influencing continuous improvements in energy efficiency regulations, improving compliance with existing codes and standards, and working with local governments to develop ordinances that exceed statewide minimum requirements. Both the C&S program advocacy and compliance improvement activities extend to virtually all buildings and potentially all appliances in California. C&S savings result from the IOUs advocacy to the California Energy Commission (CEC) and the federal Department of Energy for stricter building codes and appliance standards.

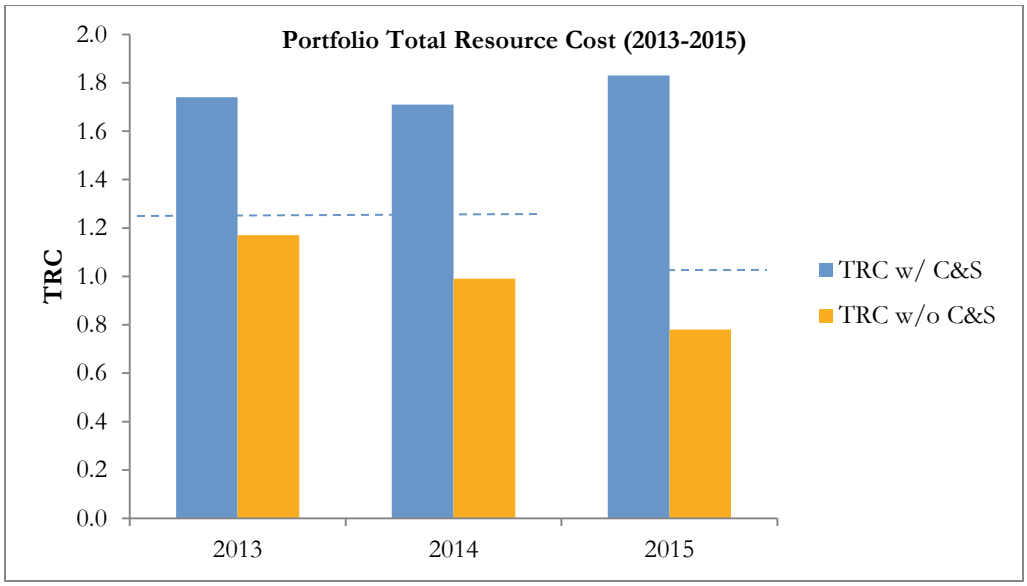
The savings from C&S programs are treated differently than the customer-oriented program savings. C&S programs have their own savings goals, distinct from the portfolio goals described previously. Codes and Standards savings greatly exceeded all of the separate Codes and Standards goals. Electric codes and

standards savings achieved 223 percent of the gigawatt-hour savings goal, while codes and standards achieved 237 percent of its peak demand savings goal and 186 percent of its natural gas savings goal.

With inclusion of savings from C&S programs, portfolio-wide evaluated net savings increase to 7,037 GWh (51 percent of total combined electricity savings); 1,212 MW (45 percent of total combined demand savings); and 105 MM Therms (37 percent of total combined natural gas savings).

As shown below in **Error! Reference source not found.**, including C&S in the TRC calculation increases the cost-effectiveness of the portfolio significantly. As discussed above, previous CPUC decisions have explored the idea of using C&S savings as a hedge against the IOUs failing to meet their savings goals or cost-effectiveness targets. In the 2013-2015 program cycle, C&S savings were not allowable as a hedging tactic for meeting performance goals, but the decision adopting separate goals is silent on whether cost-effectiveness should be estimated separately or on a portfolio basis. The concept of codes & standards providing a hedge for cost-effectiveness is illustrated in Figure 3 by the fact that in each of the program years, incorporating C&S into cost-effectiveness results in cost-effective portfolios.[20]

Figure 3: Portfolio Cost-Effectiveness Ratios, Including Codes & Standards



The blue dotted lines in the chart above show the TRC threshold of 1.25 (2013 and 2014) and 1.0 (2015) that were set by the CPUC via decision.

More information on Codes & Standards programs and savings can be found in Chapter 7: Codes & Standards.

[20] The calculation methodology of the Codes & Standards TRC is not entirely identical to the TRC methodology used for program TRC ratios and is one of the reasons that the CPUC does not explicitly count codes & standards as a hedge for cost-effectiveness. However, codes & standards do provide benefits to customers that may not apparent by looking at the portfolio cost-effectiveness results in isolation. As such, the explanation and illustrative chart are provided above.

Portfolio Savings by Program Administrator

Each of the four IOUs develops and executes a portfolio of energy efficiency programs. The savings accrue to their customers and are an opportunity to offset future procurement in their service territories. As stated above, savings goals for electricity, gas, and peak demand are set for the total portfolio, as well as each IOU. Figure 1 above shows the performance of each IOU compared to their goals for the 2013-2015 portfolio. The IOUs exceeded their electricity and peak demand savings goals, but SDG&E and SCG did not meet their natural gas savings targets.

While IOUs are required by statute to procure all cost-effective energy efficiency, neither statute nor the CPUC sets a specific penalty for not meeting the CPUC-adopted goals. However, IOUs do receive shareholder incentives for achieving energy savings and lower savings equate to lower levels of shareholder rewards. This shareholder incentive framework is known as the Efficiency Savings and Performance Incentive (ESPI). The ESPI awards the IOUs for performance in both non-resource and resource activities. Thus, while SDG&E and SCG are not levied a specific penalty for missing the natural gas savings goals, their shareholder incentive levels will be lower commensurate with the lower savings achieved. Regional Energy Networks (RENs) and Community Choice Aggregators (CCAs) also contribute savings to the portfolio. However, the CPUC does not set savings goals for these entities. Savings from RENs activities are counted within their respective associated investor-owned utility savings count. CCAs are not fully under the purview of the CPUC and therefore are not prescribed savings goals for their energy efficiency activities.

Portfolio Savings by Customer Sector

The residential, commercial, industrial, and agricultural sectors are the four primary customer segments in the state. Electricity savings for the 2013-2015 cycle were driven mainly by the commercial sector, which comprised 48 percent of total evaluated electricity savings. Comparatively, the residential sector accounted for 38 percent while the industrial and agriculture sectors contributed a combined 14 percent. This breakdown reflects a shift from the 2010-2012 cycle, in which the residential sector accounted for the majority, 55 percent, of the electricity savings. This shift from residential savings to commercial savings was driven by the residential upstream lighting program, which had successfully supported market adoption for Compact Fluorescent Lights (CFLs) by the end of the 2010-2012 portfolio cycle. As such, installations began to decrease in 2013 and thus reduced the residential savings proportion with respect to commercial savings.

Natural gas savings are driven mainly by the industrial sector, which accounted for 52 percent of the natural gas savings in the 2013-2015 portfolio. The commercial sector contributed 40 percent of gas savings while the residential sector has a much smaller impact, contributing 8 percent to the portfolio. It is worth noting that natural gas savings in the commercial and residential sectors are impacted by the interactive effects of certain other energy efficiency measures (mainly efficient lighting). These interactive effects are described in more depth in the next section, "Portfolio Savings by End Use."

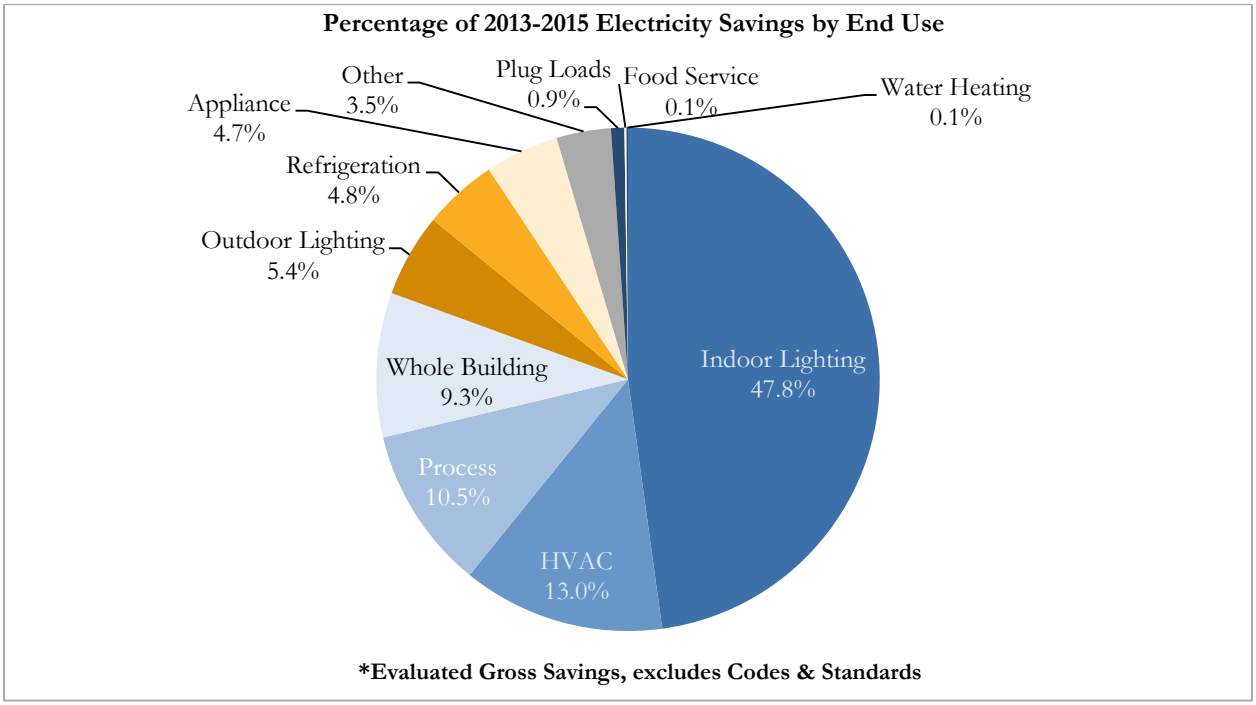
Portfolio Savings by End Use

The end uses that drive electricity savings vary by customer segment or sector. However, lighting and HVAC measures contribute large amounts of savings across the portfolio. As shown in Figure 4 below, HVAC and lighting measures combined account for 67 percent of electricity savings in the 2013-2015 portfolio, with lighting contributing 54 percent alone.[21] However, as a percentage of the portfolio, lighting savings fell from

[21] This includes both indoor and outdoor lighting.

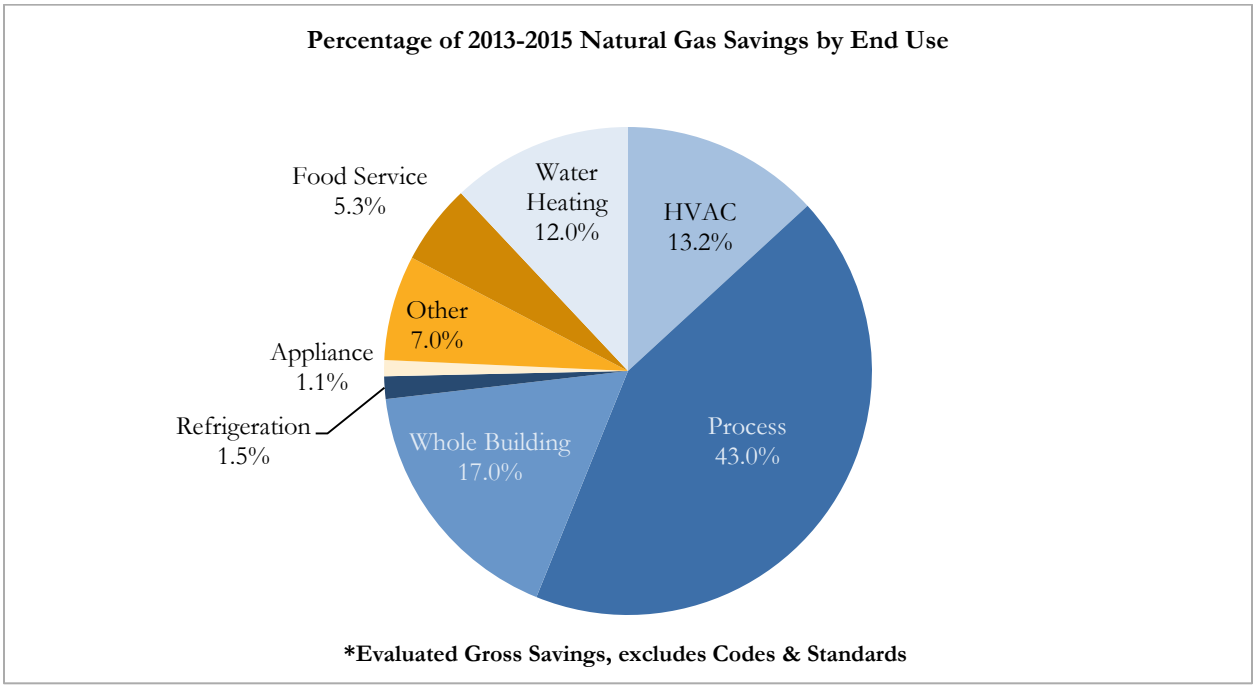
64 percent of the 2010-2012 portfolio savings to 54 percent in 2013-2015, while HVAC savings increased from 8 percent to 13 percent of the portfolio electricity savings. Savings from whole building measures increased from 3.2 percent in the 2010-2012 cycle to 9.3 percent of statewide energy savings in 2013-2015.

Figure 4: Percentage of Electricity Savings by End Use



Natural gas savings are mostly achieved in the industrial sector through process improvements in industrial processes. Whole building measures, HVAC, and water heating accounted for the majority of additional savings beyond process improvements. The remaining natural gas savings by end use are displayed in Figure 5 below.

Figure 5: Percentage of Natural Gas Savings by End Use



One anomaly in natural gas savings is the negative impact that indoor lighting measures have on natural gas savings. High efficiency lighting measures transform a larger share of their energy usage into light, emitting substantially less heat than inefficient lighting measures. The decline in heat emitted from high efficiency lighting measures may lead to an increase in the heating requirements and/or a decrease in the building's cooling requirements. In the 2013-2015 cycle, indoor lighting reduced natural gas savings by 17 percent. Plug load measures contributed a small negative impact on natural gas savings, reducing gas savings by 0.1 percent.

Emissions Savings

A key benefit of the energy efficiency programs is the reduction in emissions of Carbon Dioxide (CO2), Nitrogen Oxide (NOx), and particulate emissions that would have otherwise occurred due to energy production and consumption. While the CPUC does not set specific emissions goals for the IOUs, the emissions are estimated based on the energy saved per portfolio cycle. The calculation methodology is embedded in the cost effectiveness tool that Energy Division uses to estimate portfolio impacts. Note that these estimated emissions reductions represent the annual impact of the installed and operating energy efficiency technologies. The emissions reductions from the entire useful life of the installed technology, known as lifecycle emissions, will be significantly higher, but are not calculated here.

During the 2013-2015 portfolio cycle, energy efficiency activities reduced emissions by an estimated 3.3 million tons of CO_2 and 1.6 million tons of NOx, based on evaluated gross savings. The estimated emissions savings from Codes & Standards programs account for an additional reduction of 4.0 million tons of CO2

and 1.2 million tons of NOx. The emissions savings from both customer programs and Codes & Standards programs was the equivalent of removing 1.3 million cars from California's roads.[22]

Common Challenges across the Portfolio

The following chapters will highlight sector or program-area specific challenges identified through the evaluation studies. Each evaluation study includes recommendations for solving the identified challenges at the program-specific level. However, one common challenge was present across the portfolio, based on evaluation study recommendations, and is worth mentioning here.

Improvement in data collection is a common recurrence among recommendations across sectors and program areas. As energy efficiency activities expand to reach disadvantaged and hard-to-reach segments, such as small businesses, more data is required from existing programs and future studies in order to accurately target programs at these populations. However, improvements in data collection are not only necessary in new areas of activity. Existing programs, such as those in the commercial sector, would benefit from increased understanding of conversion rates from audits while non-resource programs, such as workforce education & training programs, could improve upon their understanding of target audiences. The balance of collecting necessary data with the expense of obtaining this data is always a consideration, but based on the prevalence of this recommendation across multiple sectors, it is apparent that improved data collection will be a necessary step as efficiency activities move beyond the "low-hanging fruit" of energy efficiency opportunities.

[22] From D05-09-043: The calculation for this statistic is x metric tons CO2 / (0.014418 metric tons CO2/day/vehicle) / 365 days per year = # vehicles taken off the roads each year due to savings that year. The data on average emissions of Bay Area vehicles was provided by the California Air Resources Board using Emfac2002 V2.2 Sept. 23, 2002; personal communication with Jeff Long, CARV, March 24, 2003. (Cited in D. Bachrach, M. Ardeman, and A. Leupp, Energy Efficiency Leadership in California: Preventing the Next Crisis. April 2003.)

Residential

Overview

With over 14 million single- and multi-family homes that house more than 39 million Californians, the residential sector accounts for 17 percent of the state's energy usage.[23] To address the needs and opportunities for savings in this sector, the 2013-2015 energy efficiency portfolio included a comprehensive suite of traditional activities (e.g., appliance rebates and lighting) for California households within the program administrators' service territories.[24] However, with an eye towards advancing the Strategic Plan's goals of moving from individual technology-based to more comprehensive approaches, the 2013-2015 portfolio continued augmenting "whole house" approaches to achieve deeper energy savings per participant. These new comprehensive programs complement the legacy whole house programs, which were started in the 2010-2012 programs. The 2013-2015 program cycle also included an expanded set of PAs, with two Regional Energy Networks and one Community Choice Aggregator launching their respective suites of residential energy efficiency programs.[25] Overall, the CPUC and IOU staff oversaw 17 energy efficiency program impact evaluations as well as five efficiency program process evaluations.

Estimated Savings

Table 4: Residential Sector Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	1,869	377	11	1,028	336	
	Net	1,316	273	11	746	272	0.9
Evaluated	**Gross**	2,015	395	9	1,088	334	
	Net	1,320	272	12	748	278	0.8
% Portfolio*	**Gross**	40%	41%	9%	15%	13%	
	Net	41%	44%	18%	18%	18%	

***represents Residential sector's percent contribution to overall evaluated portfolio savings, excluding Codes & Standards savings.**

Note that this table includes savings for lighting and HVAC measures in the Residential Sector that are also included in the savings tables provided in the separate chapters for these cross-cutting measures.

[23] Census State and County Quick Facts, https://www.census.gov/quickfacts/CA; California State Profile and Energy Estimates, Available at: ***https://www.eia.gov/state/?sid=CA#tabs-2***. Accessed 08/11/2017

[24] At the same time, the Energy Savings Assistance (ESA) program provided (and continues to provide) complementary energy efficiency measures to low income households in California, including energy efficient appliances and weatherization measures

[25] The Bay Area Regional Energy Network, Southern California Regional Energy Network, and Marin Clean Energy, respectively. See Chapter 13 on RENs/CCAs for more information.

As of the end of the 2013-2015 program cycle, residential energy efficiency programs achieved evaluated net savings of 1,320 GWh, 272 MW, and 12 million therms. These savings were achieved through a complementary suite of long-running, "traditional" programs as well as those introduced in the 2010-2012 program cycle and expanded in 2013-2015.

With the inclusion of lighting measures, the $783 million spent on residential energy efficiency programs for 2013-2015 were 30 percent of total portfolio expenditures; 22 percent of the 2013-2015 program cycle expenditures were for non-lighting residential energy efficiency programs.[26] At the end of the 2013-2015 program cycle, the PAs spent 115 percent of the initial residential sector budget.

Forty-eight percent of evaluated net energy savings in the residential sector come from lighting measures. Of the remaining savings attributable to non-lighting measures, evaluated net residential sector savings for 2013-2015 come from Home Energy Reports, pool pumps, various HVAC measures, whole home retrofits, and residential new construction.

Residential Energy Efficiency Programs

The 2013-2015 statewide programs were designed by PAs to achieve energy savings through the adoption of energy efficient products, whole house retrofits, and behavior change using rebates, incentives, contractor training, and education. The Energy Advisor Program[27] and the Home Energy Reports program were responsible for 60 percent of residential sector savings (excluding lighting measures). In addition, all PAs implemented some form of a home upgrade program that targeted either single-family or multi-family properties or both during the 2013-2015 program cycle.

The Home Energy Efficiency Rebate program from 2010-2012 was transitioned into the IOUs' statewide Plug Load and Appliances program. In addition to the Appliance Recycling subprogram that provided incentives to recycle old and inefficient refrigerators and freezers, the Plug Load and Appliances program continued to offer rebates to customers for certain high efficiency residential appliances, consumer electronics, water heaters, pool pumps, insulation, and other high efficiency technologies. By the end of 2015, the Appliance Recycling Program had closed, due to a several factors, including decreased energy savings for recycled units, as newer and more efficient units were being recycled under the program and displacing pre-2001 units that dominated the program's focus in its early years; a nearly non-existent desire in the used appliance market for older refrigerator units, as 10-year old units represent the cutoff in the used market; and closure of one of the program's recycling contractors.[28]

Highlights

Residential programs were responsible for 20 percent of total evaluated net portfolio savings (41 percent with lighting included).

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[26] Energy savings from lighting programs are discussed in detail in the Lighting Chapter of this report

[27] The Energy Advisor Program is an overarching program that includes the IOUs' online customer energy information tools

[28] Ten-year old units represent the cut-off in the used market ,meaning that customers are not looking for units older than 10 years of age. See *Appliance Recycling Impact Evaluation* Vol. 1 Report (2010-2012) at www.calmac.org; and CPUC DEER 2016 update at www.deeresources.com. Additionally, between 90 and 100 percent of units sold on major used appliance sites such as Craigslist and Pennysaver, respectively, are less than 8 years old. See *Evaluation Study of the 2004-2005 Statewide Residential Appliance Recycling Program* at www.calmac.org .Lastly, new and used appliance dealers in California only sell units that are 10 years old or less; units that are older are destroyed. See Residential Retrofit High Impact Measure Evaluation (2006-2008) at www.calmac.org .

PG&E's Home Energy Report program, initiated in 2011 as a pilot with 50,000 customers receiving reports as part of a Beta testing phase, grew over 2013-2015 into a program that delivers reports to over 1 million customers and is responsible for almost 52 percent of residential sector evaluated net savings (excluding lighting).[29] Over the course of 2013-2015, these reports provided detailed comparative energy usage information to customers and delivered net energy savings of 352 GWh and natural gas savings of 11 million therms. Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), and Marin Clean Energy (MCE) also implemented Home Energy Report programs, although evaluated net savings were significantly less than those from PG&E's program due to the size difference between PG&E's program (i.e. number of report recipients in the treatment group) and those of the other PAs in the 2013-2015 program cycle[30].

PG&E's Retail Plug-load Portfolio (RPP) Phase I Pilot ran from late 2013 through 2014. The RPP was a market transformation initiative that offered incentives to a participating retailer for the sale of specific qualified and efficient consumer electronics and appliances. Although results were mixed due to the limited duration of the pilot, the pilot allowed PG&E to establish a framework with which a larger programmatic effort could proceed. Consequently, at the end of 2015, PG&E had developed a Phase II Retail Products Platform pilot in partnership with the EPA and a number of other utilities and efficiency organizations. The Phase II pilot launched in early 2016 and the CPUC expects to present preliminary results in late 2018.[31]

Findings

Evaluations and data from the residential sector for the 2013-2015 program cycle have identified some significant challenges. Evaluation results state that:

Home Energy Reports

Home Energy Reports were first delivered to customers by PG&E in a 2011 pilot. By the end of 2015, these reports constitute the largest single residential measure based on kilowatt-hours saved and were being sent out by PG&E, SCE, SDG&E, and Marin Clean Energy.[32] Although the size of the program, in terms of the number of customers who receive the reports and recipient groupings (i.e. fuel type, geography, usage), vary by program administrator, the average 2013-2015 net savings per household ranged from less than 1 percent of typical household energy use on the low end to 3 percent on the high end.[33]

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[29] PG&E's Home Energy Report is the largest single measure, based on evaluated net savings and including lighting, in the residential sector.

[30] While the much larger treatment group in PG&E's Home Energy Report program leads to the PG&E program having the most total savings on a kWh basis, the average savings per household across programs are relatively consistent, depending on the treatment group(s).

[31] Pacific Gas and Electric Company, *Retail Plug-Load Portfolio (RPP) Trial: Evaluation Report*, April 2015. Available at http://www.etcc-ca.com/reports/pacific-gas-and-electric-company-retail-plug-load-portfolio-rpp-trial?dl=1499887695 .

[32] MCE's version is the "Home Utility Report"

[33] While one wave of MCE's Home Utility Report program had savings in 2015, the remaining three waves did not. SDG&E's 2015 savings were 2.4%. 2013-2015 savings ranged from 2.4% to 2.8% SCE savings for 2014-2015 were 1%. PG&E's 2015 savings were between one-half percent and 2.5 percent, depending on recipient wave, while historic savings (2011-2012) were approximately 1-1.5%. See "Impact Evaluation of 2015 San Diego Gas and Electric Home Energy Reports and Manage-Act-Save Programs (Final Report)", May 2017; "Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report)", May 2017; "Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)", May 2017; and "Impact Evaluation of 2015 Marin Clean Energy Home Utility Report Program (Final Report), May 2017, all available at www.calmac.org .

Home Upgrade Impact Evaluations

Single Family

By the end of 2015, six PAs were offering either the Home Upgrade or Advanced Home Upgrade program or both. The 2015 Home Upgrade Program impact evaluation estimated gross and net energy savings at the household level for both sub-programs and compared those results to prior evaluations from the 2010-2012 program cycle and 2014.[34]

All three evaluations reported similar average differences in household energy usage after program participation. The percent of electric savings for each cycle has consistently been under 5 percent, with a few instances of negative savings (i.e. an increase in usage after upgrades).[35] Although free-ridership is low, the broader program has long struggled with accurate predictions of energy savings that would result from an upgrade, and high project costs remain a participation barrier. Realization rates, or the percentage of estimated savings that actually materialize after an upgrade, are expected to improve over time as a program matures. However, realization rates for Home Upgrade and Advanced Home Upgrade Program electric savings were, with few exceptions, consistently at or under 50 percent in 2014, and then dropped to 11 percent in 2015.[36] This drop in realization rates may be the result of program redesigns implemented over the years, learning curves experienced by BayREN and SoCalREN, which only started to implement the program in 2014, or a combination of these and other factors.[37]

For gas savings, realization rates in 2013-2014 ranged from 50 percent to 185 percent depending on program administrator, with a statewide average rate of 123 percent.[38] In 2015, gas savings realization rates for each of the two programs were reported; the statewide average for the Home Upgrade Program was 91 percent, while the statewide average for the Advanced Home Upgrade Program was 11 percent. Natural gas savings realization rates by program administrator for the prescriptive Home Upgrade Program ranged from 27 percent to almost 100 percent, with average household gas savings of 44 therms. In comparison, realization rates for the custom Advanced Home Upgrade Program were at 20 percent or less for all PAs, with average household gas savings of just 16 therms. Consistent overestimation of savings is likely attributable to the savings estimation model used by PAs. Additionally, building vintage is a factor that influences savings (i.e. newer homes enrolled in the program offer "smaller scale" savings).

Statewide, 2015 evaluated net savings for the Home Upgrade and Advanced Home Upgrade Programs combined were just 9 percent, 14 percent and 34 percent of PA targets for electric, demand, and gas savings, respectively.[39]

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[34] The 2010-2012 evaluation study covered both Home Upgrade and Advanced Home Upgrade programs but did not include all IOUs due to data limitations. The 2014 evaluation study focused only on Home Upgrade. Advanced Home Upgrade was offered only by the IOUs.

[35] DNV-GL, *Final Report: 2015 Home Upgrade Program Impact Evaluation*, June 2017. Available at www.calmac.org

[36] All PAs, except SCE in 2011, had realization rates at or under 20 percent for the Advanced Home Upgrade Program. For the Home Upgrade Program, realization rates over time fluctuated wildly, with SCE seeing a 278 percent realization rate in 2011, which dropped to 42 percent in 2012. Other PAs were under 50 percent. See "Final Report: 2015 Home Upgrade Program Impact Evaluation", June 2017. Available at www.calmac.org

[37] ibid

[38] In 2013-2014, program activity was not broken out for each of the two upgrade programs.

[39] CPUC and DNV-GL, *Final Report: 2015 Home Upgrade Program Impact Evaluation*, June 2017. Available at www.calmac.org

Multi-family

Beginning in 2013, the IOUs and two Regional Energy Networks implemented a multi-family sector whole building program intended to assist property owners who wish to pursue larger multiple-measure building retrofit projects. By the end of 2015, the program had grown substantially, with an almost 500 percent increase in reported savings in 2015 compared to 2013-2014 savings, and the CPUC evaluated the program in both 2013-2014 and 2015. Although program performance over the three-year period varied to some degree by program administrator and did show improvement over that timeframe, with few exceptions, the program did not meet its energy savings goals.[40] The more recent IOU process evaluation found that although some improvements were made, the program continued to face challenges stemming from determination of an accurate baseline for program participants, data collection, savings modeling, split incentives, and free ridership, all of which contributed to low evaluated net savings and realization rates of 10 percent, 5 percent and 33 percent for kWh, kW, and therms, respectively. While the RENs' multifamily program faced similar challenges in terms of data collection and free ridership, realization rates of 60 percent, 65 percent and 54 percent for kWh, kW, and therms, respectively, were superior to those for IOU multifamily programs.[41]

Multi-Family Energy Efficiency Rebate Program (MFEER)

The Multi-family Energy Efficiency Rebate Program implemented by the IOUs offered rebates to multi-family property owners who purchased a qualified energy efficiency product for installation at their property. Rebated measures include pool pumps, appliances, lighting measures, space and water heating, windows and insulation. Lighting measures (discussed in detail later in the document in a stand-alone chapter) comprised the majority of electric savings for 2013-2015, while domestic hot water measures were responsible for the majority of gas savings.[42]

Path to Statewide Goals

As part of new Rolling Portfolio Cycle established by CPUC Decision in 2015, the program administrators filed Business Plans in January 2017. These plans describe, at a high level, the PAs' programmatic focuses through 2025. Although specific interventions vary by administrator, the Business Plans overwhelmingly articulate an intention to "drive deeper savings" in the residential sector through a mix of existing programs, including home retrofits and behavior. The Business Plans also indicate future efforts that may leverage Advanced Metering Infrastructure (AMI) data to facilitate widespread adoption of energy management technologies (EMT), per AB793 and recent CPUC direction.

Certain programs, such as the Home Upgrade Program, have struggled in recent years to achieve savings goals, due to challenges with energy savings modeling, low realization rates, and getting "the right" participants (e.g., older vintage homes, less temperate climate zones,, customers not already planning these upgrades before any program touch occurs). Corrective action in response to evaluation recommendations

[40] In 2013-2014, energy savings reported by the PAs were 28 percent, 11 percent, and 35 percent of goals for kWh, kW and therms, respectively. For 2015, although the program showed improvement, reported savings were 48 percent, 31 percent and 46 percent of goals for kWh, kW and therms. See CPUC and DNV-GL, *2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation*, February 2016; CPUC and DNV-GL, *2013-2015 Residential Roadmap Multifamily Focused Impact Evaluation*, June 2017; *2013-2015 Regional Energy Networks Multifamily Programs Impact Evaluation Final Report*, June 2017, at www.calmac.org.

[41] CPUC and Itron, Inc. *2013-2015 Regional Energy Networks Multifamily Programs Impact Evaluation Report*, June 2017, at www.calmac.org . The majority of savings are attributable to BayREN projects. SoCalREN's MF program was limited in the 2013-2015 timeframe and contributes to the lower overall realization rates estimates.

[42] SCE lighting measures contributed 90 percent of all electric savings for the program, across all IOUs, in 2013-2015.

may facilitate deeper energy savings from the existing residential building stock and result in increased savings in the sector. While expanded behavior program participation, via greater distribution of Home Energy Reports, for example, may contribute to a doubling of energy savings, it is still unclear how long-lasting these savings are and whether they persist in the absence of the program intervention.[43]

A potential opportunity to improve and expand savings in the residential sector may exist in the recent addition of Pay for Performance (P4P) programs to the suite of options available to program administrators. PG&E launched a Residential PP4P program in 2016. Program implementers bid on a specific program opportunity offered by the IOUs and in turn stand to earn financial incentives based on estimated savings measured at the customer meter. Pay for Performance opportunities may not only expand and improve current retrofit programs, but also drive increased savings from operations- and behavior-based solutions, including smart thermostats, home energy management systems, and other tailored program designs.

Additionally, the application of CalEnviroScreen in order to identify and target underserved and environmentally "at-risk" communities may offer opportunities to expand the reach of existing and future energy efficiency programs as they are woven into the larger work envisioned by SB 535 (Leon).

[43] Cadmus Group, *Long-Run Savings and Cost-Effectiveness of Home Energy Report Programs*, at http://www.cadmusgroup.com/papers-reports/long-run-savings-cost-effectiveness-home-energy-report-programs/

Commercial

Overview

The California commercial sector represents over 6 billion square feet of highly diverse building space, which includes retail stores, grocery, restaurants, offices, warehouses, schools, for the entire state. This building stock has emerged as a dynamic sector and will continue to be upgraded in the future based on new California legislation that will further penetrate commercial building markets. The commercial sector consumes 43 percent of California's electricity.[44] Given the significant portion of energy usage from this sector, commercial buildings can transform the energy efficiency market with savings and are often the focus of state policies and PA programs crafted to reduce energy consumption. In fact, throughout the 2013-2015 program period, the commercial sector represented 48 percent of electricity savings and 31 percent of natural gas savings for the entire portfolio. These savings were realized through a wide variety of end uses within those buildings, including lighting, HVAC, refrigeration, and plug loads. Evaluation studies for the commercial sector in the 2013-2015 program period included nine impact studies, four process studies, and one program assessment analysis.

Table 5 lists the business types and square footage from the Commercial Saturation Study (CSS) of all buildings served by the program administrators. The CSS building types are sorted by square footage. The total electricity usage across all PAs by business type is also included along with the percentage of electricity used by each business type. Square footage and electricity consumption in the commercial sector do not always align as the energy intensity or energy consumption per square foot of space can vary substantially by and within business types.

Table 5: Commercial Building Types by Square Footage[45] [46]

CSS Business Type	Total Square Footage	Average Square Footage	Median Square Footage	Total Usage (GWh)	% of Electricity
Warehouse	1,996,311	28,817	10,000	4,140	6%
Office	1,438,655	9,930	1,580	9,595	14%
Miscellaneous	1,320,860	5,982	2,130	11,509	17%
Retail	825,124	6,877	2,246	7,878	12%
School	711,206	47,712	33,600	3,392	5%
Health/Medical – Clinic	254,814	4,812	1,980	3,881	6%
Restaurant	197,856	2,646	1,920	6,179	9%
Food/Liquor	135,296	6,172	2,500	6,297	9%
Non-CSS Commercial Business					
College				1,817	3%
Hospital				1,925	3%
Property Managers				8,026	12%
Unknown				3,377	5%

[44] California Energy Commission, *California Energy Demand 2016-2026, Revised Electricity Forecast, Volume 1: Statewide Electricity Demand and Energy Efficiency*. January 2016.
[45] Does not include the square footage in universities, hospitals, and hotels/motels.
[46] Itron, *California Commercial Saturation Survey, prepared for the California Public Utilities Commission,* 26 August 2014

Estimated Savings

Table 6: Commercial Sector Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	2,709	482	48	1,653	782	
	Net	1,964	345	31	1,175	531	1.32
Evaluated	**Gross**	2,459	457	39	1,519	676	
	Net	1,558	292	21	985	426	1.14
% Portfolio*	**Gross**	49%	48%	39%	22%	26%	
	Net	48%	47%	31%	24%	27%	

***represents the Commercial sector's (or program area's) percent contribution to overall evaluated net portfolio savings, excluding Codes & Standards savings**

Note that this table includes savings for lighting and HVAC measures in the Industrial and Agriculture Sectors that are also included in the savings tables provided in the separate chapters for these crosscutting measures.

PAs spent $1.2 billion on commercial energy efficiency programs and produced 1,558 GWhs of electricity savings during the 2013-2015 program cycle. While commercial programs accounted for 44 percent of total portfolio expenditures on energy efficiency programs, they accounted for 48 percent of portfolio electricity savings, 47 percent of peak demand savings, and 31 percent of natural gas savings, net of free ridership. Compared to the total portfolio savings in the 2010-2012 program cycle, savings in this sector increased 10 percent for electricity, 22 percent for demand, and decreased 9 percent for natural gas. While expenditures in the commercial sector also increased from the 2010-2012 portfolio, to $1.2 billion from $970 million, the success of the commercial programs are indicated by the attendant increase in cost-effectiveness between the two portfolio cycles. Cost-effectiveness of the commercial sector improved from 0.87 TRC in the 2010-2012 cycle to 1.14 TRC in the 2013-2015 cycle.

Lighting measures, which are discussed in detail in a stand-alone chapter later in this report, were the largest spenders and savers, accounting for 42 percent of commercial sector expenditures and delivering 61 percent of electricity savings for commercial buildings. Consistent with the overall portfolio trends, HVAC measures were the second largest electricity savings measures and largest natural gas savings measures for the sector, accounting for 21 percent of electricity savings and 31 percent of natural gas savings in the sector.

Besides Lighting and HVAC measures, refrigeration efficiency measures and whole building efficiency approaches contributed the largest shares of commercial sector electricity savings, 9 percent and 4 percent, respectively. For natural gas savings, measures focused on the food service sector and process measures contributed large shares, at 19 percent and 22 percent of commercial sector gas savings, respectively.

Commercial Programs

The 2013-2015 energy efficiency portfolio includes over 80 programs that target small, medium, and large (non-custom projects) commercial customers. The programs are organized into four general program types:

- Deemed – These programs offer fixed incentive amounts for pre-approved measures (non-custom) that have a pre-determined energy savings estimate, based on rigorous engineering analyses and repeated study.
- Direct Install – These programs provide free and discounted pre-approved measures that are installed via an approved contractor.
- Third Party – These programs are designed to target hard-to-reach populations. Employing a third-party implementer allows PAs to offer new technologies with a more hands-on service approach or high level of service for that particular program.
- State and Institutional Partnerships – programs offered for state and federal government customers.[47]

These programs, under the four general types, offer a set menu of pre-determined measures and rebates or incentives at low or no cost to customers. Some programs have nominal co-payments for a customer project. These programs usually target a specific market in an effort to reach not only different types of segments of customers but to ensure that the varieties of buildings are included in the state's effort to reduce building energy consumption.

Direct install programs are broadly defined as those programs that facilitate the installation of no- or low-cost energy efficiency measures (i.e., a turnkey service) for eligible commercial customers. These programs traditionally targeted hard-to-reach customers, such as small businesses, that had not participated in energy efficiency programs. However, direct install programs have expanded in California to reach medium and large commercial customers. Direct install programs can be administered in three ways: by a third party, through a local government partnership, or by a program administrator directly.

In 2013 and 2014, 19 programs either offered direct install as the primary implementation approach or offered a direct install component in concert with other implementation approaches. Eligible customer size for some programs has doubled from under 100 kW to 200 kW, and in some cases, there is no size restriction. Government buildings and non-profits are also eligible in some jurisdictions. Installation of program measures (e.g. lighting, HVAC, refrigeration) is facilitated through program contractors, qualified local contractors, or by assisting customers in putting forth a request for proposal to find qualified installers.

Across all IOU service territories, many commercial businesses participated in at least one IOU energy efficiency program during the 2013-2015 program cycle. Business segments with the highest share of participation include food and liquor stores, hotels, and schools. Businesses with the lowest share of participation include offices, warehouses, and non-hospital health care. In addition, a larger share of businesses with higher electricity consumption participated in IOU energy efficiency programs than businesses with smaller electricity consumption.

Highlights

Commercial energy efficiency programs replaced residential program as the largest sector contributor to electricity savings in the 2013-2015 portfolio, as compared to the 2010-2012 program cycle. While part of this shift could be attributed to the decline in lighting savings in the residential sector, credit is also due to the success of numerous Commercial sector programs. As described above, Commercial programs saw an increase in total electricity and demand savings from the previous program cycle.

[47] These programs are grouped with the Commercial sector for reporting proposes and are detailed separately in the following chapter.

The Commercial portfolio not only increased total electricity savings, but also managed to do so in a cost-effective manner. The third party commercial programs, in aggregate, were cost-effective, a notable achievement as many of these programs focused on hard-to-reach markets where program implementation can be more costly than in "core" markets.[48]

- SDG&E's and SCE's Direct Install Commercial programs achieved 114 percent and 203 percent of their program electricity savings goals, respectively. SDG&E had high demand from customers and was able to reduce transaction costs through regional concentration of efforts. In 2015, SDG&E added a third implementer to focus exclusively on food service customers, often considered a hard-to-reach customer segment. SCE's program found success in partnership with local governments and through no-cost measures. In 2015, SCE began offering new plug load measures through its program.[49]

- PG&E's third party program, EnergySmart Grocer, achieved the highest combined electric and gas savings of the third party commercial programs, meeting 103 percent of its forecasted electricity savings and 87 percent of its forecasted gas savings. The program was highly cost-effective with a TRC of 2.8. This program provides no-cost audits to grocery stores, a hard-to-reach market. Feedback from customers was positive as well, with 95 percent of customers recommending the program.[50]

Findings

Third Party Programs

Commercial third party programs across the state included 53 resource and non-resource programs. Third party commercial programs focused on hard-to-reach markets, regional needs, or innovative technologies. A case study completed in 2014 focused on 38 of these programs, which consisted of a mix of custom measure and deemed measure programs. Researchers also selected ten of these programs for more detailed case study analysis. These third-party programs contributed 14 percent of the reported electric savings and 13 percent of the reported gas savings from all Commercial programs in 2013 and 2014. [51]

A particular finding of note from this study was the results of the cost-benefit analysis of direct install programs. The customers that selected their own contractor for custom measures were the least cost-effective. Those third-party programs with existing program contractors offered the most cost-effective direct install and deemed measures for customers. For customers in the grocery sector, case study findings show that both incentives and technical assistance were critical to the adoption of more energy efficient refrigeration and lighting.

Direct Install Process Evaluation

CPUC staff studied the direct install programs that reached commercial customers in the 2013-2015 portfolio. [52] The major finding of this process study was that direct install programs are installing measures and equipment with short paybacks, as opposed to undertaking deeper retrofits that have longer payback times.

[48] Opinion Dynamics. *PY2013-2014 Third Party Commercial Program Value and Effectiveness Study Report, Volume I of II,* 20 July 2016, p. 55
[49] Opinion Dynamics. *2013-2015 Commercial Direct Install Process Evaluation: Phase 1*, 3 October 2016
[50] Opinion Dynamics. *PY2013-2014 Third Party Commercial Program Value and Effectiveness Study Report, Volume I of II,* 20 July 2016
[51] Opinion Dynamics. *PY2013-2014 Third Party Commercial Program Value and Effectiveness Study Report, Volume I of II,* 20 July 2016
[52] Opinion Dynamics. *2013-2015 Commercial Direct Install Process Evaluation: Phase 1 and 2*, 25 April 2017

Deep retrofits are projects that attempt to realize larger amounts of energy savings through whole building retrofits and integration of multiple energy savings measures into one project. Naturally, these approaches may cost more and have longer payback periods than a single equipment upgrade.

The direct install study found that these remaining energy savings are not realized due to factors such as program design, customer willingness to participate, and cost. The bulk of direct install program savings to date have been from lighting, but lighting savings may begin to decline as efficient lighting technologies become more saturated in the market.

Small Business

The CPUC is encouraging new strategies to reach small business customers and achieve energy savings from this often overlooked customer class. The savings for these very small (micro) and small businesses are low but require a different approach that includes education and guidance from the PAs.

Another challenge is that many small businesses rent the commercial space and therefore face what is known as the "split incentives issue." Split incentives occur when a tenant pays a utility bill but may not have the capital or incentive to make significant, long-term investments in a property, whereas the building owner does not pay the utility bill and therefore has little or no incentive to make energy efficiency improvements to the building.

Yet another challenge results from the fact that many small businesses only qualify for "widget" -based programs that install one specific measure instead of the whole-building approach. Traditionally, these programs aimed at small businesses have offered lighting measures for quick paybacks. A more focused market penetration approach could be used in the future to engage more of these types of businesses in energy conservation.

Path to Statewide Goals

Major legislation aimed at energy efficiency passed in 2015, including AB 802, which mandates the disclosure of whole building energy data and benchmarking for commercial and multifamily buildings. In addition, SB 350 mandates the doubling of energy efficiency statewide.

The CPUC High Opportunity Program and Projects (HOPP) Ruling in 2015 authorized the IOUs to implement programs that offer incentives and technical assistance to customers to bring existing buildings into conformance with, and to exceed, the requirements of Title 24.[53] The HOPPs Ruling was an effort to expedite the authorization of programs newly permissible under AB 802. AB 802 authorized the use of an existing conditions baseline; particularly where energy savings were measured using normalizing techniques and metered energy consumption data, termed "normalized metered energy consumption.

One example of a HOPPs program is Southern California Gas Company's Commercial Restaurant Retrofit program called *Restaurant Refresh*. The Commercial Restaurant Retrofit program aims to increase the energy efficiency of existing food service buildings, since restaurants within SCE/SCG's territory make up 31

[53] California Public Utilities Commission, Assigned *Commissioner and Administrative Law Judge's Ruling Regarding High Opportunity Energy Efficiency Programs or Projects*, 30 December 2015

percent of commercial gas consumption and 10 percent of commercial electricity consumption, while only 5 percent of eligible restaurants in SCG territory have participated in other SCG energy efficiency programs.[54]

The Restaurant Refresh program encourages customers to replace existing equipment with higher efficiency models and to upgrade the energy performance of their building. Customer incentives and program energy savings reflect all energy savings, measured from the pre-existing condition of building energy usage, using a normalized metered energy consumption approach.

[54] California Energy Commission, *California Commercial End-Use Survey*. 1 August 2006. Available at http://www.energy.ca.gov/ceus/

Institutional Partnerships

Overview

Institutional Partnerships are long-standing energy efficiency programs provided by the IOUs for state and federal government customers. These programs are a subset of the commercial programs, and their savings are included in the commercial sector savings totals. However, given the distinct challenges and opportunities faced by public sector buildings, and the unique program offerings, the Institutional Partnership programs are being highlighted in this report with their own chapter.

Institutional Partnership programs traditionally serve state and federal office buildings, military bases, prisons, and universities, as well as community colleges. The partnerships face unique challenges regarding aging facilities, limited funding resources, and diverse stakeholder interests, all of which may hamper investment in energy efficiency. Conversely, these government customers, more than typical commercial entities, have a longer planning horizon and are more willing to undertake projects with longer returns on investment.

Given the recent interest in the efficiency of public buildings resulting largely from the Governor's Executive Order B-18-12 and the establishment of a discrete public sector in the Rolling Portfolio business plans, this report has provided this chapter focused on these commercial subset programs. [55,56] In the Rolling Portfolio framework, Institutional Partnerships will constitute a large portion of the public sector.

Estimated Savings

The Institutional Partnerships contributed 71 GWh of electricity savings, 13 MW of electricity demand savings, and 2 MM therms of natural gas savings to the commercial sector's evaluated net savings. The combined electricity and gas savings resulted in 49 tons of CO_2 and 28 tons of NOx emissions savings. Institutional Partnerships spent a total of $38 Million on resource programs and an additional $4.3 Million on non-resource programs.

The following table summarizes the calculated gross and net resource savings for the Institutional Partnerships.

[55] Executive Order B-18-12: https://www.gov.ca.gov/2012/04/25/news17508/
[56] Information about the Rolling Portfolio and the Energy Efficiency Business Plans: https://www.caeecc.org/

Table 7: Institutional Partnerships Programs Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	129	21	3	88	49	see Commercial TRC above
	Net	100	17	3	67	37	
Evaluated	**Gross**	111	19	3	75	42	
	Net	71	13	2	49	28	
% Portfolio*	**Gross**	2%	2%	3%	1%	2%	
	Net	2%	2%	3%	1%	2%	

***represents sector's (or program area's) percent contribution to overall evaluated net portfolio savings, excluding Codes & Standards savings**

Institutional Partnership Programs

For Institutional Partnership programs, PG&E and SCE administer resource programs throughout the state, while SCG and SDG&E run non-resource Market Education and Outreach programs. Additionally, SCE coordinates with SCG for resource programs involving natural gas projects. SDG&E serves its institutional customers through broader commercial programs. Table 8 below summarizes PG&E and SCE partnerships, excluding non-resource programs (federal government partnerships were inactive in the 2013-15 program cycle).

Table 8: Institutional Partnerships - Resource Partnerships

Customer	PG&E Program	SCE Program
Community Colleges	**PGE2110011** – California Community Colleges	**SCE-13-L-003A** – California Community Colleges Energy Efficiency Partnership
University of California and California State University	**PGE2110012** – University of California/California State University	**SCE-13-L-003G** – UC/CSU Energy Efficiency Partnership
California Department of Corrections and Rehabilitation	**PGE2110014** – Department of Corrections and Rehabilitation	**SCE-13-L-003B** – California Dept. of Corrections and Rehabilitation EE Partnership
State Agencies	**PGE2110013** – State of California	**SCE-13-L-003F** – State of California Energy Efficiency Partnership

Table 9 below summarizes SCG and SDG&E's non-resource programs.

Table 9: Institutional Partnerships - Non-Resource Partnerships

Customer	SCG Program	SDG&E Program
Community Colleges	**SCG3739-LInstP** – California Community College Partnership	**SDGE3267-LInstP** – California Community College Partnership
University of California and California State University	**SCG3740-LInstP** – UC/CSU/IOU Partnership	**SDGE3268-LInstP** – UC/CSU/IOU Partnership
California Department of Corrections and Rehabilitation	**SCG3738-LInstP** – CA Department of Corrections Partnership	**SDGE3266-LInstP** – CA Department of Corrections Partnership
State Agencies	**SCG3741-LInstP** – State of CA/IOU Partnership	**SDGE3269-LInstP** – State of California /IOU

Colleges and universities account for the majority of the savings among the Institutional Partnerships, contributing 82 percent of the evaluated net electricity savings, 73 percent of the electric demand savings, and 80 percent of the natural gas savings. College and university energy savings from these programs resulted in 82 percent of the CO_2 savings from Institutional Partnerships.

Highlights

Institutional Partnerships focused heavily on lighting and HVAC measures, which accounted for 49 percent and 32 percent all evaluated net savings, respectively. New construction whole building measures contributed an additional 15 percent of the savings. In total, 96 percent of all savings through Institutional Partnerships was attributable to whole building, HVAC, or lighting measures. The remaining 4 percent of savings largely came from custom projects and miscellaneous measures.

New construction whole building and HVAC measures also contributed significantly to natural gas savings, providing 35 percent and 45 percent of the total savings, respectively, while pool covers contributed an additional 11 percent of the natural gas savings. The remaining 9 percent of natural gas savings resulted almost entirely from custom projects and water heating measures.

Findings

Many of the findings for the broader commercial sector programs are applicable to the smaller partnerships. This is especially true with the State Agencies partnerships, which focus primarily on office buildings.

Custom projects at universities outperformed many other sectors. Colleges and universities exhibited some of the highest program influence of all commercial and industrial sector programs, with net-to-gross ratios of 0.8 or higher. Two retrocommissioning projects at universities in 2014 reflected especially high net-to-gross ratios of 0.85, though other university retrocommissioning projects exhibited much lower net-to-gross ratios that were below 0.43 (IALC 2014, p.5-7).

Industrial and Agriculture

Overview

Two of California's biggest economic contributors are also two of California's biggest energy consumers, with the industrial and agriculture sectors accounting for 18 percent and 7 percent of the state's electricity consumption, respectively, in 2015.[57] The industrial sector also accounts for a quarter of the gas consumption in the state.[58] Consequently, improving the efficiency of industrial and agricultural processes presents a significant energy savings opportunity. The industrial and agriculture programs also support Strategic Plan's vision to support the long-term economic environmental success of California agriculture." [59]

The CPUC and PAs undertook eight impact studies, two market studies, and one process study in the industrial and agriculture sectors in the 2013-2015 program cycle.

Estimated Savings

Table 10: Industrial and Agriculture Sector Savings Snapshot*

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	880	160	62	806	675	
	Net	614	110	39	539	434	1.8
Evaluated	**Gross**	623	114	41	653	544	
	Net	370	67	26	401	330	1.4
% Portfolio	**Gross**	12%	12%	41%	9%	21%	
	Net	11%	11%	39%	10%	21%	

***represents the Industrial and Agriculture sector's (or program area's) percent contribution to overall evaluated net portfolio savings, excluding Codes & Standards savings**

***Note that this table includes savings for lighting and HVAC measures in the Industrial and Agriculture Sectors that are also included in the savings tables provided in the separate chapters for these cross-cutting measures.**

[57] Email from California Energy Commission dated August 7, 2017.
[58] The industrial sector accounted for 25 percent of the natural gas demand in California. California Energy Commission, *Supply and Demand of Natural Gas in California*, Accessed at: http://www.energy.ca.gov/almanac/naturalgas_data/overview.html.
[59] See CPUC Decision D.09-09-047 (Sections 5.5 Statewide Industrial Programs and 5.6 Agricultural Programs). http://docs.cpuc.ca.gov/Published/Graphics/107829.pdf

The IOUs spent $359 million in the 2013-2015 program cycle – roughly 14 percent of total portfolio expenditures – on industrial and agriculture efficiency programs. Industrial and agricultural programs generated evaluated net savings of 370 GWh and 67 MW, which represented 11 percent of both portfolio electric and peak demand savings.[60] Fifty-nine percent of the gross electric and peak demand industrial and agricultural sector savings, respectively, were directly attributable to program interventions.

Evaluated gross natural gas savings were 41 million therms for these two sectors, with 63 percent of the industrial and agriculture gas savings being directly attributable to program interventions. The resulting net natural gas savings for the industrial and agriculture sectors comprised 39 percent of the entire portfolio's net natural gas savings for 2013-2015. Of the industrial and agriculture sectors' natural gas savings, 90 percent of them came from process measures within the sector. Industrial and agriculture process measures are efficiency measures targeted at improving specific parts of a company's operations. For example, installing heat recovery processes in an industrial facility and using that waste heat for energy in another facility operation can cut down on the amount of primary fuel needed to run that facility. Process improvements such as this therefore contribute significantly to the overall natural gas savings.

Lighting and HVAC measures, which are also discussed in separate cross-cutting chapters later in this report, were less dominant in the industrial and agriculture sectors than in other sectors. However, lighting and HVAC measures still provided, respectively, the second and third most savings in the industrial and agriculture sectors (after process improvements). Twenty percent of the evaluated net electric savings in the industrial and agriculture sectors came from lighting measures and 11 percent of electricity savings came from HVAC. For natural gas savings, HVAC makes up about five percent of evaluated net savings in both sectors combined.

Industrial & Agricultural Programs

There were 38 industrial programs and 21 agricultural programs implemented by the IOUs or by third party implementers in the 2013-2015 portfolio. Some programs focused on specific market segments, such as refineries, wastewater treatment facilities, or dairies, while others focused on specific technologies, such as boilers or air compressors. Energy efficiency projects in the industrial and agriculture sectors generally focus on manufacturing process improvements or retrofitting opportunities, but also include standardized and new construction projects. For a majority of projects, energy savings were calculated on a "custom" basis, which means that incentives were calculated based the energy saved for each specific project.

In addition, in 2015 the IOUs and CPUC, with the assistance of consultants, began to develop a Strategic Energy Management program. Strategic Energy Management is a holistic program that supports industrial facilities in making energy management part of their business culture. Strategic Energy Management is a long-term approach that provides training, technical support and incentives to industrial customers to improve the efficiency of their facilities and operations and assist them in maintaining that efficiency. Implementation of the program will begin early in 2018.

[60] The estimates in Table 10 include savings from lighting and HVAC projects, as well as deemed savings from projects in those sectors, all of which are discussed in other chapters in this report. The discussions of evaluated savings in the remainder of this chapter are based on industrial, agriculture and large commercial ex post evaluation results, which include only custom calculated projects.

Highlights

Based on evaluated savings results, the industrial and agriculture programs achieved nearly one third of the natural gas savings goal established for the entire portfolio. Evaluated net electricity savings were 60 percent of the originally reported net savings, yet the programs were cost effective.

To help resolve the issues causing differences between IOU reported data and evaluated results, the IOUs and CPUC staff have been engaging in a collaborative process to review and approve project savings estimates prior to implementing projects.[61] This process is known as the ex-ante review process. The intent of the early review process is to reduce the gap between PA-reported savings and evaluated savings and to provide immediate feedback to the utilities with respect to savings calculation methodologies and program influence metrics. The collaborative early review process proved useful in resolving project-specific questions in the 2013-2015 portfolio period. However, the early or "ex ante" review process has proved difficult to implement due to delays in obtaining data and performing analyses on the part of the implementers, IOUs, and ex ante reviewers. The project specific results and other direction provided by the review team have generally not resulted in more accurate savings estimates for projects that do not undergo early review. To address these issues, a stakeholder working group comprised of IOU and CPUC staff and stakeholders including program implementers developed different approaches to the early review process through a collaborative effort that may reduce delays and result in wider dissemination of information going forward.[62]

Findings

Impact Evaluation

Custom Impact Evaluations: Beginning in 2013, custom program impact evaluations were completed on an annual basis; the impact evaluations included industrial, agriculture, large commercial, and nonresidential new construction custom projects to verify energy savings reported by the IOUs. For 2013-2015, the studies included a comprehensive suite of field-based evaluations, as well as a qualitative project practices assessment, to discern possible changes in ex-ante savings development practices.

The combined results from 2013-2015 showed a significant variation in the IOU evaluated results versus the reported savings.[63] The combined evaluation results were based on a sample of 513 projects and found that the IOUs achieved from 44 to 80 percent of their reported gross savings, depending on the IOU and fuel type. The percentage of savings that were a direct result of program intervention was similar in magnitude to the results from the past few evaluation cycles.

A novel element incorporated in the 2013-2015 evaluations was a qualitative Project Practices Assessment carried out for all 513 impact sample points. Practice Assessments are designed to yield results that can be used to target improvement in program administrator treatment of important gross impact parameters, methods and procedures that are common across applications. Practice Assessment findings also identify critical weaknesses in documentation and reporting. The Practice Assessment form and procedure was

[61] Decision 11-07-030, *Attachment B: Custom Review Process*; and, Decision 12-05-015 *Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach*, 18 May 2012, p. 344
[62] Track 2 Working Group documents are available at http://t2wg.cadmusweb.com/.
[63] The 2015 results are available at. https://pda.energydataweb.com/#/ Click on the "advanced search" link and on the "From Work Order" drop-down list select (ED_I_IAL_5-Itron) 1315 IALC Impact.

designed to document both the PA and evaluator conclusions and to ensure that results could be analyzed objectively to assess conformance with policy guidelines, best practices and program rules.

Key findings from the impact evaluation include:

- Documentation for many of the sample projects was insufficient to initiate an appropriate independent analysis and investigation.
- PA-reported gross savings differ from evaluated savings for three primary reasons: (1) observed changes in operating conditions, (2) baseline specifications (i.e., determination of the "status quo" baseline energy use from which the additional energy savings were measured), (3) IOU calculation methods. Other reasons for differences included incorrect equipment specifications, ineligible equipment, and incorrect measure counts.
- Customer interviews representing 575 installed projects were conducted to understand the role of the program and other market factors in their decision to take an energy efficiency action. The information obtained through these interviews was converted into a net to gross ratio. The general conclusions drawn from the results of this large sample were that free ridership remains high for custom programs.

Nonresidential Whole Building Impact Evaluation**:** In addition, a Nonresidential Whole Building Impact Evaluation was conducted in 2013. The evaluation addressed non-residential new construction whole building projects that received incentives under the statewide Savings by Design program. The evaluation estimated gross impacts for 25 projects across all PAs, conducted professional telephone surveys supporting net-to-gross estimation for the 25 gross sample points, and provided engineering reviews of the 25 gross sample points to support the qualitative project practices assessment. Case weights were used to extrapolate the evaluation results to the population. With all the sample points included, the mean statewide realization rates were 0.92 for kWh, 0.79 for kW and 0.57 for therms. Although the kWh gross realization rates (GRRs) for the sampled projects ranged from -0.46 to 2.28, the resulting overall kWh GRR of 0.92 was slightly above the 0.9 default ex ante GRR adjustments for the SBD program. However, the overall program natural gas GRR of 0.57 was significantly below the default 0.9 ex ante GRR adjustments for the SBD program.

The difference in the savings between the ex ante estimate and the ex post results were primarily due to the differences in modeling assumptions, calculation methods and baseline assumptions. The four principal reasons that reported gross impacts differed from evaluated results were (1) differences in operating conditions, where the field visit revealed differences in the building's operational conditions that warranted adjustment to the building energy models, (2) differing baselines, where the evaluation team determined a different baseline than the one used by the PA was more appropriate, (3) differing calculation methods, where the evaluator used a different modeling approach, and (4) model calibration, where models were adjusted to calibrate model energy using billing-meter or end-use data. On a statewide basis, the net-to-gross ratio for the whole building program was estimated at 0.53 for kWh and 0.51 for therms and 0.53 based on source MMBTU (one million British thermal units) which was the basis of sample design.[64]

Water-Energy Nexus: CPUC evaluators also conducted a study that centered on calculating changes in water utilities' electricity consumption coincident with the 2015 statewide urban water reduction mandate.65 The

[64] DNV-GL, *NRNC Whole Building Impact Evaluation Report PY-2013*, 20 July 2015. Available at https://pda.energydataweb.com/#/.
[65] Water agency customers are served by both industrial and agriculture programs.

study used billing data to calculate changes in water-related electricity consumption for a selection of 32 water agencies throughout the state. The dataset focused on electric accounts associated with groundwater pumping, water transport, and potable water treatment, upstream of end users and therefore exclusive of energy inputs directly from end users or wastewater treatment. Based on the analysis, the evaluation team developed data-driven recommendations for adjustments to the CPUC water-energy calculator.66 In part, the study found that embedded energy use reductions underwent a downward trajectory in two parts, one from 2013 to 2014 and one from 2014 to 2015, with an especially large reduction 2013 to 2014 for groundwater-reliant water agencies. Based on limited data, the energy intensity of groundwater production and distribution appeared to have increased over the 2013-2015 period, coincident with increasing drought conditions.

Path to Statewide Goals

The 2015 Potential and Goals study reflected ongoing potential for cost-effective energy efficiency in the industrial sector. With the filing of the Energy Efficiency business plans for the new Rolling Portfolio Cycle framework, industrial and agriculture programs will be updated to reflect these remaining savings opportunities.

While the industrial and agricultural savings opportunities vary by service territory demographics, there are a handful of overarching new approaches to note. Pay for performance strategies and increased use of data analytics to target specific customer needs at industrial and agriculture facilities will combine to create a more incentivized, targeted customer segment. In addition, strategic energy management approaches are designed to promote persistent operational, organizational, and behavioral changes that yield greater efficiency gains. Strategic Energy Management is a key strategy of the U.S. Department of Energy's industrial energy efficiency strategy. Overall, with support from the CPUC, California IOUs have opted to make substantial changes to the former Continuous Energy Improvement program and transition to a resource-acquisition program adopting major design components and M&V protocols from successful programs implemented by Northwest utilities in the U.S. and Canada.

[66] The CPUC, working with stakeholders and PAs, developed a calculator to determine energy savings from and the cost effectiveness of cold water conservation projects carried out jointly by the CPUC and water entities. See *Water/Energy Cost-Effectiveness Analysis*, Navigant Consulting, April 2015. http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5356.

Heating, Ventilation, and Air Conditioning

Overview

The high demand for air conditioning in California has made heating, ventilation and air conditioning (HVAC) is one of the largest energy end uses and the single largest contributor to peak demand. The CEC estimates that cooling buildings comprises up to 30 percent of total demand in the hot summer months, and that poor installation and maintenance may result in potential energy losses of 20 to 30 percent.[67] As the use of space cooling and heating has increased, the state has struggled to encourage the market to adopt higher efficiency units and develop a sustainable, quality-focused HVAC industry.

To address these issues, the Strategic Plan called for a "transformation" of the industry to ensure that HVAC technology, equipment, installation, and maintenance are of the highest quality to promote energy efficiency and peak load reductions. To meet these objectives, the PAs have designed and implemented a variety of HVAC programs to transform the industry by encouraging the purchase of highly efficient HVAC units, encouraging high-quality HVAC system installations, and demonstrating to property owners that quality installation and proper maintenance of HVAC systems leads to increased savings, greater comfort, and improved indoor air quality.

During the 2013-2015 energy efficiency program cycle, CPUC staff carried out ten HVAC studies. The key takeaways from the two most prominent HVAC impact evaluations, the Upstream HVAC Study and the Quality Maintenance Study, are:

- The Upstream HVAC Commercial Installation program achieved the greatest amount of evaluated savings, with an overall gross realization rate of 79 percent for small packaged HVAC units, which represent the majority of the equipment served by the program (as noted earlier, realization rate is a comparison of the savings reported by an IOU to the savings determined through evaluation studies).
- The evaluated savings results for the Commercial and Residential Quality Maintenance programs have been disappointing. Evaluation study results recommended enhancing the programs by including improved fault detection diagnostics to reduce the need for maintenance activities that do not deliver savings, such as small refrigerant charge adjustments.

[67] California Energy Commission, *Strategic Plan to Reduce the Energy Impact of Air Conditioners* (June 2008), Available: http://www.energy.ca.gov/2008publications/CEC-400-2008-010/CEC-400-2008-010.PDF

Estimated Savings

Table 11: HVAC Program Savings Snapshot*

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	840	199	21	558	296	
	Net	627	151	15	414	217	1.1
Evaluated	**Gross**	627	178	14	449	230	
	Net	422	129	9	314	158	0.9
% Portfolio**	**Gross**	12%	19%	14%	6%	9%	
	Net	13%	21%	13%	8%	10%	

*** These savings are also reported in the respective sector summary tables in earlier chapters.**
**** Represents HVAC's percent contribution to overall evaluated net portfolio savings, excluding Codes & Standards savings.**

The PAs spent $543 million on core HVAC efficiency programs in the 2013-2015 program cycle, resulting in evaluated savings of 422 net electric GWh and 129 net demand MW. Sixty-seven percent of electric savings and 72 percent of demand savings were directly attributable to the program interventions. Realization rates were high with programs returning a 67 percent net realization rate on electricity savings, a 85 percent net realization rate on demand savings, and 60 percent net realization rate on gas savings.

It should be noted that other programs not explicitly directed at HVAC systems include measures that improve HVAC system efficiencies (e.g., residential whole house and commercial building retrocommissioning programs), so the HVAC-specific programs do not account for all HVAC-related energy savings achieved in the portfolio. Savings from HVAC measures achieved in various sectors are also included in the sector-focused chapters.

HVAC Energy Efficiency Programs

The IOUs' HVAC portfolio consists of four core HVAC energy efficiency subprograms:

- Upstream Commercial Distributor
- Commercial Quality Maintenance
- Residential Quality Maintenance
- Residential Quality Installation

Since the 2010-12 program cycle, there have been no fundamental changes in the nature of these programs. However, program design changes have been implemented to improve energy savings and cost effectiveness. In addition to these core programs, PG&E and SDG&E are implementing Commercial tune-up programs delivered by third-party contractors.

Highlights

HVAC programs have more promise when accompanied by a more active solicitation of new energy efficiency program customers. This effort differs from program to program and depends on PAs providing companies and homes with a clear view of how an HVAC program can help them, how it provides rebates, and how the program saves them money over time.

Communication and coordination are important in terms of learning about best practices on the part of other IOUs and sharing constructive information informally. This can be done through workshops, forums, and a focus cost effectiveness. What has also proven effective is training implementers to engage in quality workmanship and hiring competent technicians to do professional grade installation and maintenance. New technologies can also improve HVAC programs increasingly over time, depending on cost and applicability.

The best example of success has been the Commercial Upstream Rebate Program, which continues to provide the majority of the commercial sector HVAC savings. As mentioned previously, the Upstream Commercial HVAC program has achieved the greatest amount of evaluated savings, with an overall gross realization rate of 79 percent for small packaged HVAC units, which represent the majority of the equipment served by the program.

Findings

HVAC evaluations for the 2013-2015 cycle focused on the subset of the HVAC programs providing the largest contribution to statewide savings – namely, Upstream HVAC and Commercial Quality Maintenance programs, with a 2015 study of Residential Quality Maintenance.

HVAC 1: Commercial Upstream Rebate Program

The evaluation of the HVAC Commercial Upstream Rebate Program (HVAC-1) verified that upstream programs continue to provide the majority of the commercial sector HVAC savings. These programs focus on equipment ranging from small packaged and split HVAC units to large rooftop units and chillers. The study, like the program, was designed to look at the efficiency of the incented equipment. The findings for the Upstream HVAC Program Impact Evaluation are summarized below:

- **Chiller and Large Unit efficiency.** Actual efficiencies of the installed equipment were lower than ex ante estimates of assumed efficiency levels. The resulting low savings levels were most prevalent for air-cooled chillers and large unitary systems, which had ex-post gross savings realization rates of 11 percent and 15 percent, respectively. Savings estimates reported by the IOUs did not pass basic quality control checks.
- **Small and Medium Package HVAC equipment efficiency.** Program savings for small and medium packaged HVAC units (up to 20 tons) evaluated in 2015 improved in comparison to 2013-14. This impact evaluation returned lower than expected savings for the smallest size units (under 5.5 ton) but found good realization rates for units 5.5–20 ton. The primary driver of the low realization rates was that, on average, the full-load efficiencies of the installed equipment were lower than the program assumptions.

  The evaluation team believes that the primary reason for the improvements in packaged HVAC units between 5.5 and 20 tons was the code update and updated version of DEER for 2015. The 2013-2014 programs had to utilize different baselines within the calendar year, while the 2013 Title 24

Building Efficiency Standards (effective July 1 2014) were fully in force during the 2015 program year. The field-testing of 5.5-20 ton units showed that performance was in alignment with current DEER assumptions.

- **Economizers.** The evaluation team found that a considerable savings potential is not realized because many economizers for unitary systems installed through the program are not functioning properly. One-quarter of the economizers were found to be not working. Further tests uncovered errors such as improperly wired sensors, indicating that the economizer was not installed correctly and never functioned as designed. The economizer failure rate of 25 percent is a great improvement over earlier impact evaluations, but additional savings can be obtained by improving the reliability of economizers installed in the equipment covered under the Upstream HVAC program.
- **Net to Gross Ratio (NTGR).** DNV-GL's data collection and NTGR expansion analysis resulted in an overall NTGR score of 64 percent for the upstream program. The ex-ante NTGR assumption was 85 percent for most programs and measures.

HVAC 3: Commercial Quality Maintenance

The Commercial Quality Maintenance (HVAC-3) study gathered field observations on installation rates and contractor maintenance practices, and observed several challenges with program implementation. Gross savings for commercial maintenance measures have improved since the 2010-12 evaluation cycle, partially because implementers have focused on enrolling contractors that deliver higher quality work. Findings for the five main measure groups in the programs were:

- **Economizer repair:** A statewide installation rate was calculated as the number of properly functioning economizers divided by the number of economizers tested. The site-level results were combined across all IOUs, which resulted in a statewide installation rate of 61 percent.
- **Thermostats:** Evaluations noted many thermostats that did not meet the program requirements for set-back (cooling) or set-up (heating) temperatures during unoccupied building periods. The Statewide realization rate was 89 percent, indicating energy savings were obtained even though program requirements were not met.
- **Coil cleaning**: Coil cleaning results have been stable over the 2013-15 evaluation cycle. Applying the revised simulation savings across all measure variations resulted in average gross realization rates of 108 percent for electric energy (kWh) savings and 112 percent for electric demand reduction (kW).
- **Supply fan controls:** The installation rate of the supply-fan adjustment was 47 percent for programs offering this measure, which was much lower than anticipated.
- **QM measure group:** Unlike the other IOUs, which reported savings on a measure-by-measure basis, SCE reported savings for a single quality maintenance measure group. This measure group represents unitary HVAC repair and maintenance initiatives under the SCE's Commercial QM program. The overall realization rate for the QM measure group was 90 percent primarily due to high realization rates for coil cleaning, economizer repair, and supply fan control measures.
- **Net to Gross Ratio (NTGR).** The net savings analysis consisted of a series of phone interviews with participating contractors. DNV-GL's data collection and NTGR expansion analysis resulted in an overall NTGR ratio score for kWh savings of 31 percent for the IOU core quality maintenance programs, and a NTGR score for kWh savings of 41 percent for third party tune-up programs. Ex-ante assumptions for NTGR were between 73 percent and 85 percent, depending on the program. Although there were large variations in responses across the surveyed contractors, the low mean

scores indicate a potential high level of free-ridership among the current pool of participating contractors.

For the *Residential Quality Maintenance* programs covered by the HVAC-3 report, a billing analysis was conducted on customers in the PG&E and SDG&E service territories. Although gross savings realization rates were high, net savings obtained from a non-participant comparison group analysis were disappointing. SDG&E's residential QM program had no net energy savings and PG&E's had a net realization rate of 26 percent in 2015. The billing analysis conducted for the residential quality maintenance program shows wide swings from gross savings to net savings. These results foreshadow some of the difficulties in applying a billing analysis to this type of program.

HVAC 5: Laboratory Test

The Laboratory Test (HVAC-5) study evaluated economizer performance and system faults for common commercial rooftop HVAC systems. Results of the packaged roof top unit tests provided the following findings:

- **Economizers.** The impact of economizers on system efficiency is significant and unexpected due to higher than anticipated economizer leakage. For units tested with economizers, average outdoor airflow with the economizer damper completely closed exceeded code specified minimum outdoor air ventilation requirements for common commercial buildings. Excess ventilation loads (over code-required minimums) can have a significant negative impact on cooling energy consumption. For economizers that were fully open, the average outdoor airflow less than 100 percent, limiting the amount of free cooling supplied.
- **Out of the Box Efficiency.** The units as delivered from the manufacturer (out-of-the-box, or OOTB) did not consistently perform at the rated efficiency. Small (3 ton) units tested within the published Air Conditioning, Heating and Refrigeration Institute (AHRI) efficiency and capacity values, but larger (7.5 ton) units had efficiency below the rated values. Units failing the OOTB test required modifications in the lab to achieve the published efficiency and capacity ratings.
- **Impact of Field Conditions.** Optimal efficiency was achieved at airflow rates lower than the value used in standard AHRI tests due to higher duct system resistances commonly observed in the field. The additional fan power required to increase the airflow rate to the AHRI test value at field observed duct resistance overshadowed any efficiency gains.
- **Refrigerant Charge Fault.** Undercharge conditions had a much greater (negative) impact on capacity and efficiency than overcharge conditions. The optimal refrigerant charge for a unit may slightly exceed the factory charge under extreme conditions.
- **Coil Cleaning.** Condenser coil blockage has a greater negative effect on system efficiency than on evaporator coil blockage.
- **HVAC Fault Diagnosis.** The diagnosis and adjustment of refrigerant charge is difficult to conduct in the field. Most fault detection diagnostic protocols are based on conditions, which are nearly impossible to measure in the field with standard contractor maintenance equipment. Troubleshooting multiple faults through a logical fault detection diagnosis protocol will reduce or eliminate false alarms, misdetection, and misdiagnosis. Cleaning coils, changing filters, and checking airflow are important first steps before attempting additional fault detection diagnosis on the unit.
- **Refrigerant Gauge Attachments.** Tests of the effects of attaching and detaching refrigerant hoses showed a decrease in both efficiency and capacity as the number of attachments increased. The loss

of efficiency due to this routine service action underscores the need to avoid unnecessary refrigerant charge checks and adjustments.

- **Instrumentation Accuracy.** The least accurate temperature sensors tested recorded a 10 ºF temperature error at typical hot day test conditions. Such errors can result in misdiagnosed or undiagnosed faults.

HVAC 6: HVAC Permit and Code Compliance Market Assessment

The *HVAC Permit and Code Compliance Market Assessment* (HVAC-6) study examined residential single-family central HVAC replacements. At a high level, findings from the study suggest that:

- **Permitting rates are low,** with the estimate of the true permitting rate somewhere between 8 percent and 29 percent. Under current market and enforcement conditions, permitting does not lead to increased energy efficiency of HVAC change outs. The energy efficiency levels for both permitted and non-permitted sites were similar and did not meet the Title 24 requirements.
- **There were documentation gaps for permitted installations.** Three-quarters of permitted installations had the required Home Energy Rating System (HERS) compliance forms. Performance tests found some systems were out of compliance even though the documentation indicated that these units were in compliance.
- **There is a lack of knowledge** among homeowners and contractors of the Title 24 requirements.
- **There is inconsistency in enforcement** across building departments, and inconsistency in enforcement across inspectors within a single building department.
- **Contractors drive the decisions about permitting,** even though homeowners bear the responsibility.

Path to Statewide Savings

The Upstream HVAC program represented the largest reported savings and had an overall gross realization rate of 79 percent for small packaged HVAC units, which represent the majority of the equipment served by the program. Net to gross ratios were 64 percent, down somewhat from the 80 percent net to gross ratios in the 2010-2012 program cycle. Upstream HVAC programs are expected to continue to deliver cost effective savings for the HVAC portfolio in the future. As the market penetration of new HVAC technologies continues to grow, piloting evaluation methods for these new technologies is necessary in order to improve the reliability of savings estimates for these systems.

The results for the Commercial and Residential Quality Maintenance programs have been disappointing. Evaluations of the quality maintenance programs since the 2006-2008 evaluation have returned low gross realization rates. Gross realization rates have improved for some measures during the current evaluation cycle, but a drop in the net to gross ratios has dampened these improvements. Maintenance programs need to be re-designed before they can be counted on to deliver significant savings into the future. Continued support for and improvement of workplace education and training is also required to supply the industry with an expanded pool of qualified HVAC installation and maintenance technicians.

Lighting

Overview

Lighting represents over one quarter of residential and commercial electricity use in California and has historically represented at least half of total portfolio-level savings.[68,69] The Strategic Plan cites energy efficient lighting as a critical element of its zero net energy vision and envisions a 60 to 80 percent reduction in California's electric lighting energy consumption by 2020 (over a 2010 baseline). California Assembly Bill 1109 (Huffman, 2007), known as the California Lighting Efficiency and Toxics Reduction Act, supports this goal by phasing out some traditional, low efficiency incandescent lamps by 2018.[70] For this reason, the CPUC directed program administrators to start shifting energy efficiency program support away from basic spiral compact fluorescent lamps (CFLs) and toward more efficient lamps (e.g., light-emitting diode [LED] lamps) and other advanced lighting technologies starting with the 2010-2012 program period.[71] This guidance continued into the 2013-2015 program period.

When manufacturers first introduced CFLs into the market in large quantities during the 1990s, consumers had poor opinions of the products, and many products were of inferior quality and had higher costs than traditional bulbs. These issues may have contributed to the slow CFL uptake by California consumers. To help avoid similar challenges with early LED lamps, the CPUC issued a new lighting program requirement during the 2013-2015 period to ensure that program-discounted LED lamps were of high quality. In December 2012, the CEC published a California-specific quality standard for LED lamps known as "the CEC specification" or the "California quality specification."[72] Around the same time, the CPUC issued a decision that required the California IOUs to provide energy efficiency program incentives only for LED lamps that meet the CEC specification within one year of the standard's adoption by the CEC.[73] During the "transition period"—until January 2014—the CPUC allowed the IOUs to continue to provide incentives for LED lamps that met the ENERGY STAR standards. Starting in 2014, compliance with the CEC specification for LED lamps became the mandatory quality standard for LED lamps included in the IOUs' incentive programs.

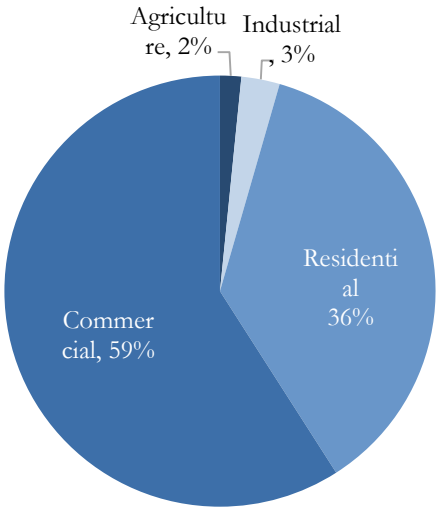
[68] California Energy Commission, 2011. 2011 Integrated Energy Policy Report. Publication Number: CEC-100-201-001-CMF.
[69] In the 2006-2008 program cycle, indoor lighting accounted for 58 percent of the evaluated electric savings.
[70] California State Assembly, 2007. Assembly Bill 1109, Ch. 534, Article 10.02. Lighting Toxics Reduction.
[71] California Public Utilities Commission, 2009. D.09-09-047: Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets. Page 7. October 2009.
[72] California Energy Commission, 2012. Voluntary California Quality Light-Emitting Diode (LED) Lamp Specification: A Voluntary Minimum Specification for "California Quality" LED Lamps (Final Staff Report). CEC Publication number CEC-400-2012-016-SF. December 2012.
[73] CPUC, 2012. D.12- 11- 015. Decision Approving 2013-14 Energy Efficiency Programs and Budgets.

Estimated Savings

Table 12: Lighting Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	2,722	406	-23	1,243	131	
	Net	1,892	284	-15	867	99	1.4
Evaluated	**Gross**	2,863	430	-26	1,297	121	
	Net	1,739	268	-15	790	83	1.3
% Portfolio (Evaluated)	**Gross**	56%	45%		18%	5%	
	Net	54%	43%		19%	5%	

Figure 6: Percent of 2013-2015 Evaluated Net Energy Savings from Lighting Measures by Sector



Across all programs in the 2013-2015 portfolios, lighting measures accounted for 54 percent of the net electricity savings (1,739 GWh). Of this, SCE achieved 57 percent, PG&E 33 percent, SDG&E 10 percent, and MCE achieved the remainder (less than one-tenth of one percent of evaluated net electricity savings). Expenditures associated with these savings totaled $783 million, exceeding the$626 million budget for lighting programs by 25 percent. The lighting category accounts for just below 30 percent of the total $2.64 billion of expenditures for the 2013-15 portfolio.

Figure 2 shows the percent of evaluated net energy savings from lighting measures in the 2013-2015 portfolios across all programs and program administrators by sector. As shown, the commercial sector accounted for the largest share of evaluated net electricity savings from lighting measures at 59 percent, followed by residential at 36 percent.

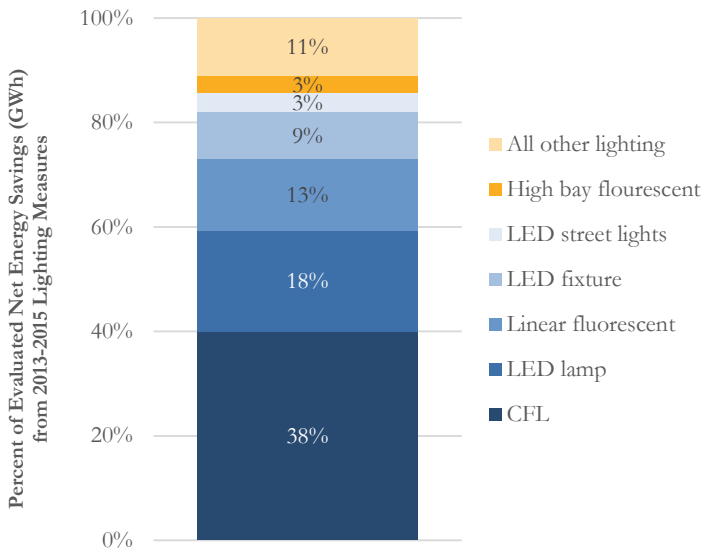
Lighting Programs

The Primary Lighting program provides incentives to manufacturers to produce energy efficiency lighting measures. Key measures included CFLs, LED lamps and fixtures, and dimmable fluorescent ballasts, as well as other efficient lighting technologies. The Primary Lighting program was responsible for the largest share of savings from lighting measures, accounting for 46 percent of evaluated net electricity savings from lighting measures in the 2013-2015 portfolio.

The CPUC directed the IOUs to begin phasing out incentives for basic CFLs during the 2010-2012 program period.[74] The Primary Lighting Program's budget across the three IOUs decreased from $168 million during the 2010-2012 period ($56 million per year) to $70 million in 2013-2014 ($35 million per year).[75] Most of this budget reduction was related to IOUs ramping down their incentive support for basic CFLs. The IOUs began introducing LED lamps into the Primary Lighting program in relatively small quantities during 2013 and in somewhat greater quantities in 2014 and 2015.[76] Nonetheless, CFLs still accounted for the largest share of evaluated net energy savings from lighting measures in the 2013-2015 portfolios across all programs and program administrators by lighting measure group at 38 percent (see 14), while LED lamps accounted for 18 percent.

The Statewide Commercial Deemed Savings program accounted for the second largest share of evaluated net energy savings from lighting measures included in the 2013-2015 portfolio (12 percent).[77] The purpose of the 2013-2015 Commercial Deemed Savings program, a component of the Statewide Commercial program, was to encourage installation of energy-efficient equipment and systems in retrofit and new installations by reducing the initial investment costs associated with these measures. The program also aimed to offer a simple application process to reduce participation costs. The 2013-2015 program included measures such as energy-efficient linear fluorescent fixtures, retrofit kits, and lamps; metal halide lamps; induction fixtures; LED fixtures and retrofit kits; and other energy-efficient lighting measures.

Figure 7: Percent of Energy Savings by Lighting Measure



Findings

The CPUC and energy efficiency program administrators conducted seven impact evaluations, eleven process studies, and two market studies for lighting, based on the 2013-2015 program period. These studies provided substantial information regarding lighting measures. Some of the key findings from these studies are highlighted below. Since LED lamps began to increase in significance to the portfolio during this period, many of the findings focus on LED measures. Below are findings regarding pilot and trial programs, LED quality and pricing, and the effects of the IOUs' upstream lighting programs on California's market for residential replacement lamps.

Pilot and trial programs:

Key findings regarding 2013-2015 pilot programs focused on lighting measures include:

[74] Page 7. Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets, CPUC ED, October 2009.
[75] Page 18. California Residential Replacement Lamp Market Status Report: Upstream Lighting Program and Market Activities in California through 2015, DNV GL, November 2016.
[76] Page 11. Impact Evaluation of 2015 Upstream and Residential Downstream Lighting Programs, DNV GL, April 2017.
[77] All other programs in the 2013-2015 portfolio accounted for less than 10 percent of evaluated net energy savings from lighting measures.

- PG&E and SCE offered a Midstream LED incentive program during the 2013-2015 period that provided incentives to distributor-level suppliers for sales of LED lamps and fixtures to commercial customers with the goal of increasing adoption rates for these technologies in this sector. PG&E's trial program offered incentives for lamps only, while SCE's pilot program offered incentives for lamps and fixtures. The suppliers typically passed most or all the incentives along to customers. Evaluations indicate that these pilots were successful, that the trials appear to have motivated customers to undertake the projects, and that these projects generated higher energy savings than anticipated.[78, 79]
- SCE offered another pilot program to support training for lighting controls installers through the California Advanced Lighting Controls Training Program (CALCTP). Evaluation results show that the CALCTP Installer Technical Course is well designed, well executed, and fills a gap in available training for lighting controls installers. However, the evaluation also concluded that there is room for improvement in the training, and was not able to decisively measure if the training was having a meaningful impact on the skills and knowledge of the individuals who participated in the training.[80]

LED quality and pricing:

Key findings regarding LED quality and pricing during the 2013-2015 period include the following:

- A large-scale laboratory test subjected screw-based LED lamps to common stress conditions associated with typical household installations. The study exposed more than 600 LED lamps to high temperatures (from operating in enclosed fixtures and recessed downlights) and thermal cycling (the heating up and cooling down of LED lamps associated with switching them on and off). Draft study results suggest that one-fifth of LED lamps rated to last 25,000 hours failed after just 4,000 hours of operation (20 percent), with many of the failures concentrated in a small number of lamp models.[81]
- Lamp manufacturers' representatives suggest that the upstream component of the IOUs' Statewide Primary Lighting program was their main motivation for producing LED lamps that met the CEC's California quality specification for LED lamps in 2015.[82] Without the requirement that LED lamps must adhere to the specifications to obtain program incentives, manufacturers largely would not have produced lamps with these characteristics.
- Among the IOUs' residential electric customers who purchased LED lamps during 2015 and 2016, satisfaction was high. However, because LED lamps that meet the California quality specification comprised such a small share of LED lamp stock among California retailers (13 percent, as of winter 2015-2016), it is unlikely that the specification is the primary driver of customer satisfaction.[83]
- Results from two studies suggest that prices for screw-based and linear fluorescent LED lamps continue to decline, including lamps used in both residential and nonresidential applications. One suggested that in the near term average LED lamp prices will decrease by 21 percent per year and

[78] Evaluation of the Southern California Edison Commercial Midstream LED Lighting Distributor Pilot Program Final Report, Evergreen Economics, May 2015
[79] Pacific Gas and Electric Company's Lighting Innovation Midstream Trial Evaluation Final Report, Evergreen Economics, October 13, 2015
[80] Final Report: Lighting Controls Training Assessment, ASWB Engineering and Opinion Dynamics Corporation, April 2016
[81] 2013 -2014 Work Order ED_I_Ltg_1: LED Lab Test Study Interim Results Memo, Itron and Erik Page & Associates, August 2016
[82] Impact Evaluation of 2015 Upstream and Residential Downstream Lighting Programs, DNV GL, April 2017
[83] *Ibid.*

luminaires (fixtures and lamps sold together) by 20 percent per year.[84] Another suggested not only that price has declined in California retail stores, but that the availability of screw-based LED lamps in these stores has increased over time.[85]

Other effects of the upstream lighting program on the residential lighting market:

One additional key finding regarding the upstream component of the IOUs' 2013-2015 Statewide Primary Lighting program relates to the program's effects on California's market for residential replacement lamps. An impact evaluation of the IOUs' 2015 upstream lighting program concluded that without the program's support significantly fewer customers would have purchased energy efficient lamps in discount, drug, grocery, and hardware channels. In absence of the program, customers would have purchased comparatively inefficient lamps in these channels. This finding was not the case in big-box channels like do-it-yourself stores, mass merchandise stores, and wholesale clubs, in which the retailers likely would have offered similarly efficient lamps without the program.[86] Thus, the upstream lighting program seems to have the greatest influence on retail sales in the non-big box channels.

Path to Statewide Goals

Lighting comprises one-fourth of California's electricity use and efficient lighting will continue to play a critical role in achieving state energy efficiency goals. While considerable strides have been made in lighting efficiency as the market moves toward LED adoption, efficiency opportunities will remain in the integrated demand side management and behavioral spaces. Given the changes in markets under Energy Independence and Security Act (EISA), continuous rapid price declines for LEDs, increased customer familiarity with LEDs, removal of most CFL incentives, and the increased market share of halogens, ongoing assessment of lighting program decisions is important.[87] Program opportunities for lighting controls include CPUC programs to maintain savings over time through these technologies. Research into these described areas will potentially be conducted in the next round of EM&V studies.

Additional program opportunities for lighting will become apparent once the new EISA code takes effect on January 1, 2018. The EM&V Plan, which outlines upcoming studies for the new portfolio cycle, aims to study these emerging program opportunities in depth.

[84] California LED Workpaper Update Study: Final Report, Navigant Consulting, Inc., August 2015
[85] California Residential Replacement Lamp Market Status Report: Upstream Lighting Program and Market Activities in California through 2015, DNV GL, November 2016
[86] Impact Evaluation of 2015 Upstream and Residential Downstream Lighting Programs, DNV GL, April 2017
[87] EISA refers to the Energy Independence and Security Act. EISA sets efficiency standards for general service lamps, which currently include the following light bulbs: general service incandescent lamps, compact fluorescent lamps, and general service light-emitting diode (LED) and organic light emitting diode (OLED) lamps

Zero Net Energy / New Construction

Overview

Commercial and residential new construction programs offer incentives, design assistance and training, and operate pilot projects aimed at advancing California's Zero Net Energy building goals. Zero Net Energy can be defined in multiple ways, but the definition proposed in the California Energy Commission' s 2013 Integrated Energy Policy Report, is the following:

"A ZNE Code Building is one where the net of the amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single "project" seeking development entitlements and building code permits, measured using the California Energy Commission's Time Dependent Valuation (TDV) metric. A ZNE Code Building meets an Energy Use Intensity value designated in the Building Energy Efficiency Standards by building type and climate zone that reflect best practices for highly efficient buildings." [88]

Despite the proposed definition above, there is still some discrepancy in ZNE definitions used by policymakers and industry, necessitating further discussion and research.

In 2012, Governor Brown issued Executive Order B-18-12, which established the following Zero Net Energy targets for California's state buildings. In conjunction with the ZNE goals set for the residential and commercial building sectors set in the California Long-Term Energy Efficiency Strategic Plan, the ZNE goals for California include the following:

- All new residential construction and all new commercial construction in California will be zero net energy by 2020 and 2030, respectively
- 50 percent of existing commercial buildings will be retrofit to ZNE by 2030
- All new state buildings and major renovations shall be ZNE beginning in 2025
- 50 percent of existing state-owned building area by 2025 shall be ZNE

In addition to continued policy support and building codes from the CPUC, the IOUs currently have seven active programs within the ZNE/NC program area. These new construction programs coordinate closely with Codes & Standards, Emerging Technologies, and Workforce Education & Training programs.

The CPUC and PAs completed five evaluation studies in the ZNE program area for the 2013-2015 program cycle. The findings of these market and process studies are synthesized below.

[88] California Energy Commission, *2013 Integrated Energy Policy Report*, 20 February 2014; p.36

Estimated Savings

Table 13: Zero Net Energy Programs Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	279	90	8	194	109	
	Net	197	61	5	135	75	1.9
Evaluated	**Gross**	231	80	7	161	92	
	Net	142	50	4	98	55	1.4
% Portfolio*	**Gross**	5%	8%	7%	2%	4%	
	Net	4%	8%	6%	2%	4%	

***represents sector's (or program area's) percent contribution to overall evaluated net portfolio savings, excluding Codes & Standards savings**

The estimated savings for new construction and ZNE programs in 2013-2015 for residential and commercial buildings are included in the respective sector chapters. The portion of these savings that resulted from programs dedicated to new construction is also presented in this chapter.

PAs spent $149 million on new construction programs in the 2013-2015 program cycle, or 6 percent of portfolio expenditures. New construction programs saw a 16 percent increase in expenditures compared with the 2010-2012 portfolio, which reflects the increasing focus on ZNE goals and approaches.

Evaluated net savings, or those savings directly attributable to program intervention, were 142 GWh, 50MW, and 4 million therms. These savings accounted for 4 percent of electricity portfolio savings, 8 percent of demand savings, and 6 percent of natural gas savings. Approximately 60 percent of the total new construction electric and gas savings were attributable to program intervention, a 20 percent increase in program influence over the 2010-2012 programs.

The commercial and residential sectors accounted for 73 and 15 percent of the new construction electricity savings, respectively. However, the residential sector accounted for the majority of natural gas savings in the new construction sector, contributing nearly 60 percent of the therms savings for the program area.

Zero Net Energy / New Construction Programs

Efforts to promote ZNE growth in the construction market exist throughout IOU programs, including Codes & Standards and sector-specific activities. A handful of IOU customer-oriented programs focus on achieving ZNE market growth through new construction activities. PG&E, SCE, and SCG all implement a Residential New Construction program. In 2014, the IOUs launched a new incentive design for their residential new construction program, the California Advanced Homes Program (CAHP).

For non-residential buildings, PG&E, SCE, and SDG&E run the Savings by Design program. Savings by Design offers financial incentives to support integrated design or whole buildings, encourages green building initiatives, and provides technical design and energy modeling assistance.

The CPUC and IOUs have also enacted various activities to plan the market growth of ZNE buildings, including holding ZNE Commercial Action Plan stakeholder meetings between 2010 and 2014, as well as ZNE and Sustainable Communities Pilots that support financial, technical, and design assistance to such projects.

CPUC and IOUs also initiated planning for a 2015-planned California Advanced Homes Program element to support a targeted set of advanced builders to incorporate high performance walls and attics into their business models in advance of the expected inclusion of these measures in the 2016 Title 24 standards update. CPUC staff launched a ZNE Residential Action Plan and related stakeholder process in 2015. A ZNE Residential Stakeholder Group was formed and has since participated in several workshops addressing Community-scale ZNE solutions and the labeling of ZNE buildings and homes.

Highlights

IOUs report contributing financial, technical, design and other resources to 75 out of 81 known ZNE or ultra-low energy use commercial buildings in California between 2008 and 2014. Most of these buildings are publicly owned and operated and include schools, libraries, and local government buildings. An increasing number are large, private facilities exceeding 50,000 ft^2 in size.[89]

Findings

Residential ZNE Market Characterization

The PG&E Residential ZNE Market Characterization study completed in 2014 provided a deep dive into aspects of the ZNE market from owners' perceptions of ZNE homes to the financial and lending community's barriers and solutions to financing ZNE homes. The study found almost one thousand near-ZNE homes (i.e. highly efficient with distributed generation), representing one percent of the residential construction market. The prevalence of near-ZNE homes, and the comparative scarcity of full ZNE homes, indicated that the market might be more ready to embrace near-ZNE construction rather than full-ZNE construction in the short-term.[90] The study also found that while full-ZNE homes are technically feasible, the largest barrier to ZNE homes is the incremental cost. Based on interviews with building professionals, the incremental cost of a ZNE home is 5-15 percent more than the cost to build a home to existing building codes (lifecycle energy savings are not factored into the incremental building cost).[91]

Miscellaneous Energy Loads Study

Phase I Study

The series of Miscellaneous Energy Loads (MEL) studies sought to understand the relative confidence in MEL energy use estimates to better inform ZNE planning and modeling efforts. Energy consumption from Miscellaneous Energy Loads (MELs) in residential buildings is growing faster than any other end use category, yet it has been difficult to develop precise estimates of energy use in this category. If MEL use in homes is modeled incorrectly, ZNE designs may not perform as expected when constructed. Phase I found that existing MEL energy estimates have a high degree of uncertainty. The study found that televisions, set

[89] Energy Division data request to IOUs, self-reported IOU data, August 2014
[90] TRC Energy Services, *Residential ZNE Market Characterization*, 27 February 2015; p.15
[91] The incremental cost difference here will inevitably change with changes to the building code in subsequent years.

top boxes (STBs), and desktop computers comprise 65 percent of annual energy consumption for MELs. However, given trends in consumer electronics, it is expected this distribution will change as MEL energy use becomes more widely distributed in the home. The study concluded with an initial identification of the issues to tackle in order to improve MEL modeling for ZNE purposes.

Phase II Study

To further understand the impacts of MELs on the ZNE space, Phase II reviewed methods used and current predictive models of residential energy use, focusing on demographics and home attributes related to both individual and aggregate plug loads. The study found that verification of compliance is becoming more challenging and that there are still significant gaps in the data and documentation available to ZNE evaluators. The study concluded with recommendations on how to improve evaluation of MELs.

Savings by Design Market Potential, Characterization and Best Practices Enhanced Program Participation Study

As described above, Savings by Design is an IOU program focused on improving the efficiency of non-residential new construction. This market potential study found that renovations comprised a large portion of the non-residential construction market, especially as existing facilities are repurposed for different industries, presenting an opportunity to target existing facility renovations for energy efficiency improvements.

Barriers to Savings by Design participation included the cost of energy efficiency measures, the need for participant education, and difficulties in serving the needs of accelerated design processes. To address these barriers, the study found that market actors such as designers and general contractors are the primary drivers of whether or not a project enrolls in the Savings by Design program. These market actors tended to respond favorably to educational opportunities while building owners are motivated to participate in energy savings programs by awards and green certifications.[92]

ZNE Compliance Options for Distributed Energy Resources:

The *ZNE Compliance Options for Distributed Energy Resources: Phase I* study explored the potential for distributed energy resources (DER) in ZNE-type homes and buildings. The study found there were no programs that combined incentives for distributed generation and energy efficiency programs, which presented a challenge to customers seeking simple financing options. As the definition of ZNE adopted in the 2013 IEPR includes the stipulation for on-site energy generation, the lack of integrated generation and efficiency incentives presented a hurdle for ZNE adoption.

Path to Statewide Goals

Achieving Zero Net Energy goals still requires additional market development. Increasing ZNE prevalence in the building market will require additional support through increased demand for efficient buildings, as well as a trained and educated workforce capable of supplying increased demand for ZNE construction. In addition, understanding of how ZNE buildings fit into the wider energy efficiency programs and grid operations context needs further development.

[92] Navigant Consulting, Inc., prepared for SCE, PG&E, and SDG&E. *Savings By Design Market Potentials, Characterization and Best Practices Enhanced Program Participation Study*. CALMAC ID: SCE0357.01. February 7, 2014.

ZNE goals support increased coordination and improvement among numerous existing energy efficiency programs. As more ZNE design elements move into building codes and become standard across the construction industry, California will see enhanced efficiency benefits.

Codes and Standards

Overview

The Codes and Standards Program conducts research and advocacy to support adoption of energy efficiency technologies and practices in California's Building Energy Standards (Title 24), Appliance Standards (Title 20), and the Federal Department of Energy Appliance Standards. The program also supports compliance enhancement and other code support activities. The research aspects of the Codes and Standards program provide vital technical and market research on the market readiness and cost-effectiveness of measures that are under consideration for code adoption. Supporting the transition of a new product or practice into a code-appropriate industry standard reduces the overall cost of energy efficiency and spurs additional innovation, as practitioners seek the most cost-effective means to comply with the new code element.

For the 2013-2015 program cycle, the CPUC set separate goals for the IOUs' Codes and Standards programs.[93] The 2013-2015 Codes and Standards program goals are provided in Table 13.

Table 14: 2013-2015 Codes and Standards Portfolio Goals

	2013-2015 Codes and Standards Goals by Investor-Owned		
	Electric (GWh)	**Demand (MW)**	**Natural Gas (MM Therms)**
PGE	776	107	2
SCE	800	111	-
SDGE	181	25	0.2
SCG	-	-	5
Total	1,756	243	7

Savings from Codes and Standards are consistently the most cost-effective savings available to IOU efficiency programs, since these programs impact all new buildings constructed and appliances purchased in the state.

[93] D.12-11-015: *Decision Approving 2013-2014 Energy Efficiency Programs and Budgets*. 15 November 2012

Estimated Savings

Table 15: Table 14: 2013-2015 Codes and Standards Savings Snapshot[94]

		Energy Savings		
		Electric (GWh)	**Demand (MW)**	**Natural Gas (MM Therms)**
Reported	**Gross**	11,002	2,311	66.9
	Net	3,385	610	33.3
Evaluated	**Gross**	12,282	2,267	92.5
	Net	3,597	546	38.6

Table Notes:

- **Gross Savings are IOU territory potential savings, adjusted for the Energy Savings Adjustment Factor, which accounts for not all buildings being 100% in compliance with the building code and less than 100% of appliances sold complying with current minimum appliance standards.**
- **Program Net are IOU territory Gross Savings adjusted for Naturally Occurring Market Adoption (NOMAD) and attribution of activities to the program.**
- **Gas savings are reported without taking into account interactive effects of efficient lighting measures (see description of interaction effects in the Executive Summary).**

IOU Codes and Standards Programs spent $49 million in the 2013-15 program cycle, or three percent of the total energy efficiency portfolio expenditures, and accounted for approximately 53 percent of the evaluated net electricity portfolio (combined Codes and Standards and incentive programs) savings. Nearly all of IOU Codes and Standards reported savings come from the buildings and appliances advocacy subprograms. Consequently, the impact evaluation focused on the activities of these two subprograms. The Compliance Enhancement subprogram is a non-resource program and, as such, does not have savings attributed to it.

Based on evaluated savings, Codes and Standards subprograms are cost-effective with TRCs of 8.8 for federal appliance standards, 12.5 for California appliance standards (T-20), and 5.0 for California building codes (T-24), respectively. This is in part due to the low program costs but also because the program has influence over all customers who purchase new buildings or appliances in the state, not just entities who opt to participate in voluntary efficiency programs.

Codes and Standards Programs

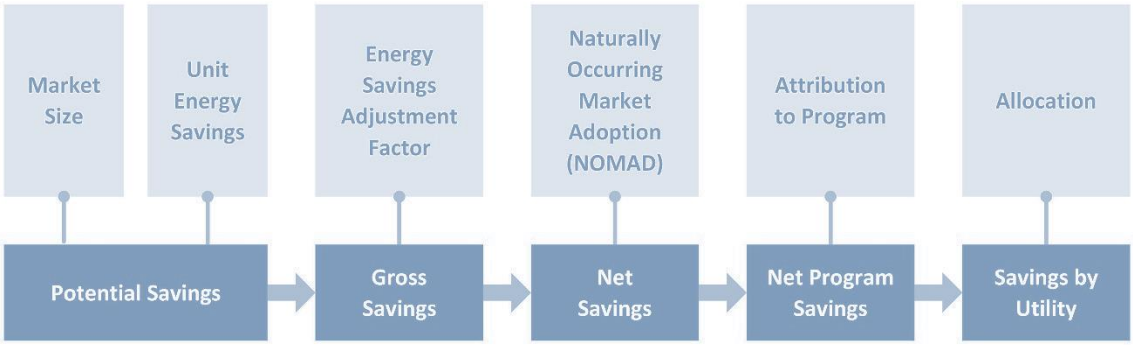
The Codes and Standards *advocacy* programs generate savings from two broad categories of efficiency regulations: appliance standards and building codes.

The Codes and Standards Program engages with code-setting bodies, such as the CEC and the U.S. Department of Energy, to directly influence the development of codes and standards that strengthen energy

[94] DNV-GL, Cadmus Group, *California Statewide Codes and Standards Program Impact Evaluation Report Phase Two, Volume One: Appliance Standards* (CALMAC Study ID: CPU0169.01). 23 May 2017.
CALMAC Study ID: CPU0170.01 *California Statewide Codes and Standards Program Impact Evaluation Phase Two, Volume Two: 2013 Title 24*

efficiency regulations.[95] This activity is largely achieved by conducting research for specific code changes, known as Codes and Standards Enhancement (CASE) studies, some of which are used by the CEC to set new standards. The program supports federal standards by engaging in both administrative and legislative processes together with other stakeholders. The process chart in Figure 3 below shows the steps in determining the energy savings due to codes and standards advocacy programs.

Figure 8: Codes and Standards Advocacy Program Evaluation Protocol



In addition to advocacy, the Codes and Standards program also engages in *compliance improvement* activities for California standards by providing education and training that targets building departments, architects and other industry actors responsible for enforcing or complying with Building Energy Code and Appliance Standards requirements.

Finally, the Codes and Standards Program also supports local jurisdictions in the development and implementation of *reach codes*, which exceed minimum statewide code requirements. The CPUC defines reach codes as codes that must be adopted formally by an enforcement jurisdiction. The Code must be legally enforceable and enforced by the jurisdiction.[96]

Highlights

Even though 63 percent of the evaluated electricity savings for Codes and Standards resulted from appliance standards advocacy – both state and federal – much attention is paid to building codes (Title 24) evaluated savings and most specifically determining the amount of compliance. The determination of compliance adjustments for Title 24 is resource intensive, involving field audits of buildings and modeling analysis.

Changes from previous evaluations included capping building code compliance at 100 percent.[97] This approach modifies the previous evaluation method to avoid giving credit to IOUs for savings due to buildings implementing measures that result in energy savings that surpass what is required just to meet code. This was accomplished by limiting the potential credit to no more 100 percent of new code requirements.

[95] Program and subprogram descriptions can be found in the Codes and Standards Program Implementation Plans, 01/03/2011. See www.eestats.cpuc.ca.gov .
[96] D.10-04-029 *Decision Determining Evaluation, Measurement, and Verification Processes for 2010 Through 2012 Energy Efficiency Portfolios*. 21 July 2008; p.46
[97] Energy savings were bounded between 0% and 100% of potential savings.

Advocacy

The IOUs advocate for higher efficiency codes and standards by supporting research and analysis on potential new building codes and appliance, lighting and equipment standards. These studies include the potential energy savings due to a specific new code or standard. In Tables 14-17 below, the number of completed studies is in the "Research and Analysis" column. Of these, those studies that actually made it into the CEC docket for Codes and Standards rulemaking are shown in the column labeled "Docketed". The number of docketed energy savings measures (either new codes or standards) is shown in the "Adopted" column.

"Nonresidential" is essentially commercial building codes and commercial appliances, lighting or equipment, while residential includes buildings up to three stories and "cross cutting" are codes and standards that can be applied to either category.

Tables 17-20 (below) show Title 20 appliance standards, federal appliance standards, and Title 24 building standards work for 2013-2015. Table 17, summarizes work in all three Codes and Standards advocacy areas.

Table 16: Title 20 Standards

Title 20 - 2013-2015			
Sectors	**Research and Analysis**	**Docketed**	**Adopted**
Nonresidential	1	0	0
Residential	1	1	0
Crosscutting	13	13	4
Total	15	14	4

Table 17: Federal Standards

Federal Standards - 2013-2015			
Sectors	**Research and Analysis**	**Docketed***	**Adopted**
Nonresidential		51	
Residential		28	
Crosscutting		64	
Total	0	143	0

*** Docketed Comment Letters for Federal Standards**

Table 18: Title 24 Standards

Title 24 - 2013-2015			
Sectors	**Research and Analysis**	**Docketed**	**Adopted**
Nonresidential	11	11	11
Residential	6	6	6
Total	17	17	17

The majority of Codes and Standards Enhancement study preparation for the 2016 building standard was also conducted during the 2013-2015 timeframe. Work on twenty-two 2016 building code measures was undertaken during the 2013-2015 timeframe, but not included in the total shown above or in the table showing totals across advocacy efforts below.

Table 19: Codes and Standards

All Codes and Standards - 2013-2015			
Sectors	**Research and Analysis**	**Docketed**	**Adopted**
Nonresidential	12	62	11
Residential	7	35	6
Crosscutting	13	77	4
Total	32	174	21

Compliance Improvement

In the 2013 – 2015 period, the training format for the Compliance Improvement subprogram was expanded from classroom training to include webinars, live online (real time) courses, and online self-study courses. The statewide team completed over 600 classroom sessions and developed and delivered 15 different online courses and webinars and five online self-study trainings. In Table 21, the row labeled "decoding" refers to courses that specifically involved interpreting the revised building code. Code training was also provided in a webinar format to provide easier access for interested parties who preferred a web-based training as opposed to in-person training.

Table 20: Compliance Improvement Training Classes

Type	Research and Analysis
Classroom	629
Decoding (webinar)	12
Virtual (live online)	13
Online Self Study	5 courses/ 429 users

In addition to training, Compliance Improvement developed Fact Sheets and Trigger Sheets that address various topics; tools such as the Forms Ace and Reference Ace; and other resources including checklists and guides to facilitate compliance and enforcement.

Reach Codes

The IOUs worked with local jurisdictions to prepare the way for adoption of codes that exceed 2016 Title 24 as part of the normal three-year cycle of local jurisdiction adoption of California Uniform codes. A key part of that effort was the program administrators' initiation of cost effectiveness studies to support the adoption of Cool Roof Reach Code ordinances by the City of Los Angeles, City of Pasadena, and County of Los Angeles, respectively. The studies address product cost, energy savings, cost-effectiveness and GHG reductions to support reach code requirements for residential and nonresidential Cool Roofs in all 16 climate zones.

Program Administrator work with the CEC was instrumental in the development of the CALGreen ZNE Tier. The CALGreen ZNE Tier is the basis of 2016 Reach Codes including ZNE. Key to the ZNE tier is the Energy Design Rating, which calculates the Time Dependent Valuation of all energy consumed or exported by the building. The Energy Design Rating is an extension of the Title 24 performance method simulation software, CBECC-res. The Codes and Standards statewide team has been gathering supporting information and participating in algorithm development for this simulation tool.

Findings

Appliance Standards

Within appliance standards, battery chargers accounted for 58 percent of appliance standard electricity savings and televisions accounted for 32 percent of electricity savings. The top gas energy savings came from new federal standards for top loading clothes washers (37 percent) and gas water heaters (31 percent). Compliance was high for all measures except for small motors.

Building Codes

Capping building code compliance at 100 percent reduced the net program evaluated savings by 34 percent. The largest reduction to energy savings from this methodological change was for non-residential alterations, which saw a 37 percent reduction in evaluated energy savings. Non-residential new construction evaluated savings were reduced by 21 percent. Residential evaluated savings were reduced by 1 percent.

Residential savings suffered a much smaller reduction in evaluated savings because there are more residential buildings that are not up to code. The compliance for **residential** building codes was much lower than in the previous evaluations. One recurring issue was hot water recirculation pumps running longer than they should because they were not connected to an on-demand control system as required by code. In one instance, the building did not even meet the 2008 code requirements.

The evaluation team had difficulty in recruiting enough **non-residential** buildings to visit and evaluate. The usual statistical analysis had to be replaced by a Monte Carlo analysis because the sample size was too small.

Another change in the methodology was to use a whole building approach for evaluating building code energy savings, where possible, in order to account for interactions between efficiency upgrades. In this approach, building data collected at actual site visits was entered into a building simulation program. The simulation modeled interactions between the different energy savings measures. Previously, the energy usage of individual measures were numerically added and did not take into account how different measures might interact within building to offset other upgrades' impacts.

Path to Statewide Goals

PG&E, as the Codes and Standards statewide lead, is ramping up a "Code Readiness" program that will make data needed to implement new codes and standards available to the CEC in an effort to accelerate adoption of new measures into the code. The IOUs have set adequate metrics in their business plans to continue to advocate for codes and standards and ensure compliance.

Integrated Demand-Side Management

Overview

The Integrated Demand Side Management (IDSM) statewide program is a strategic planning program implemented by all four of California's IOUs. The program aims to ensure that the IOUs work together and pool their actions, lessons learned, and resources to develop and promote programs and strategies that provide integrated demand side energy solutions to customers in all market segments (residential, commercial, agriculture, and industrial). As a statewide program, the IDSM program has a dedicated budget, as well as specific objectives and goals.

The CPUC first directed the IOUs to promote IDSM for customers in the Energy Efficiency, Demand Response, Distributed Generation, and Low Income Energy Efficiency proceedings in 2007. However, in late 2014, the CPUC initiated a stand-alone rulemaking, R. 14-10-003 to:

> …consider the development and adoption of a regulatory framework to provide policy consistency for the direction and review of demand-side resource programs

In September 2015, the scope of this rulemaking was expanded to include not only integrated demand-side management topics, but integration of distributed energy resources as well. The resulting Integrated Distributed Energy Resources (IDER) rulemaking (R.14-10-003) was scoped to determine how distributed energy resources could meet system needs as an alternative to traditional grid investments, so IDSM-specific evaluation activities were put on hold. The following chapter describes the evaluation studies completed for the 2013-2014 program years.

Estimated Savings

IDSM is classified as a non-resource program; consequently, there are not any energy savings attributed to or reported for this program.

IDSM Programs

The IDSM budget supported the core collaborative and coordination functions of the IOUs while other IDSM activities were funded via other programs throughout the IOU portfolio. The statewide IDSM program budget for the 2013-2015 program cycle was $11 million, of which $8 million (72 percent) was spent.[98]

The activities of the IDSM statewide program during the 2013-2015 program cycle focused on four different areas of activity in support of the core tasks established in D.09-09-047:

[98] IDSM activities are funded with energy efficiency funds, as well as funds from demand response programs. While the IDSM budgets are authorized through the energy efficiency funding application proceedings, only the energy efficiency funds are discussed in this report.

- **Technology tracking** – The IDSM Task Force continued to track emerging technologies that have a combination of energy-efficiency, demand response, and/or distributed generation capabilities.
- **Integrated Audits** – Each IOU continued to enhance their integrated audits offerings, including solar-related functionality.
- **Pilots** – The IDSM program continued to support various pilot projects, including many Zero Net Energy projects.
- **Integrated Marketing –** The IDSM program continued to support marketing and outreach efforts that combine marketing for energy efficiency, demand response, and distributed generation programs into combined or single stream marketing efforts.

Highlights

IDSM activities in the 2013-2015 program cycle were driven by the increasing focus on zero net energy buildings. In the 2010-2012 program cycle, the IDSM program developed an online integrated assessment tool and a unified project inspection process. These activities were aimed at streamlining project applications, reimbursement, and inspection processes for customers.

Given the ZNE policy drivers, IDSM activity focused on supporting ZNE pilot projects and emerging integration technologies. In accordance with CPUC direction, the IOUs participated in an IDSM Task Force that identified and promoted integration opportunities and tracked projects where there were integrated efforts underway in order to identify and develop best practices. Additionally, the IDSM program continued to fund improvements to the integrated audit tools developed in the previous program cycle.

Findings

IDSM evaluations for the 2013-2014 program years consisted of three market studies. The first two studies focused on the residential and small commercial sectors, while the third study summarized findings from three non-residential IDSM project case studies.

The residential and small commercial studies identified customer profiles of those customers that adopted integrated solutions. These studies found that direct sales efforts by distributed generation contractors were a main driver behind adoption of integrated energy efficiency and distributed generation.[99]

Among small commercial customers, there were different rates of uptake for integrated solutions across business types. Schools were much more likely than any other business type to adopt IDSM solutions, particularly those including distributed generation. Adoptions that combined demand response and energy efficiency (but not distributed generation) were most common among food/liquor establishments. Offices, restaurants, and managed properties had the lowest propensity to adopt IDSM projects. Other drivers of IDSM solutions included technology advancements that support integration (energy management systems, smart thermostats and HAN/in-home displays) and public policy, such as zero net energy goals.[100]

[99] Evergreen Economics, *IDSM: A Study of Preferences and Patterns of IDSM Uptake in California's Residential and Small commercial Markets*. October 2015

[100] Evergreen Economics. *Integrated Demand Side Management Market Characterization Study, Residential and Small Commercial Markets.* August 2014.

An additional lesson learned and documented in the IDSM case studies were that IDSM offerings are not delivered via programs that combine resources, but by human resources that support the intelligent combining of programs. As such, further consideration is needed on how external non-utility market actors and funding sources drive customer behavior and to what extent utility rates provide incentives to encourage IDSM in line with California loading order and climate goals.[101]

Path to Statewide Goals

The Integrated Distributed Energy Resources proceeding continues to evolve, with a current focus on implementing the IDER Competitive Solicitations Framework, which seeks to develop a framework for all-resource solicitations. These all-resource solicitations aim to facilitate the deployment of distributed energy resources to displace or defer the need for capital expenditures on traditional distribution infrastructure. Integrated offerings have the potential to be particularly useful in this regard by the very nature of providing multiple grid or customer services in one package. As such, the IOUs' IDSM programs continue to promote integration of programs and technology for customers in energy efficiency, demand response, and distributed generation. Integration of demand-side technologies will continue to be driven through the CPUC's continued push of zero net energy policies in the residential and commercial sectors and custom projects in the industrial sector.

[101] Evergreen Economics. *Integrated Demand Side Management Case Study Report.* May 2016

Workforce Education & Training

Overview

The Workforce Education and Training (WE&T) Program represents a portfolio of education and training activities aimed at supporting the achievement of IOU energy savings targets, as well as the workforce objectives set forth in the California Long-Term Energy Efficiency Strategic Plan (Strategic Plan). As noted in the Strategic Plan, the vision for the workforce is that, by 2020, "California's workforce is trained and fully engaged to provide the human capital necessary to achieve California's economic energy efficiency and demand-side management potential."[102]

The CPUC first provided guidance to the IOUs regarding Workforce Education and Training activities in the 2010-2012 program cycle. In 2013, at the direction of the CPUC, the statewide WE&T program team hired the Donald Vial Center for Labor in the Green Economy to develop a comprehensive approach to WE&T for the EE programs, in line with the goals in the Strategic Plan and the Needs Assessment recommendations.[103] On May 2, 2014, the Donald Vial Center finalized its recommendations in the document *Workforce Issues and Energy Efficiency Programs: A Plan for California's Utilities* (Guidance Plan). In June 2015, the CPUC approved a joint IOU Program Implementation Plan Addendum, describing which of the Guidance Plan recommendations would be initiated in 2015. These guidance documents and decisions influenced the topics evaluated and studied in the 2013-2015 program cycle.

The WE&T program completed two process evaluations and five market/indirect impact evaluation studies for the 2013-2015 portfolio. These seven studies generated 30 recommendations for program improvement.

Estimated Savings

Workforce Education & Training is a primarily non-resource program, so energy savings are not attributed nor measured for WE&T.

The one exception is the LivingWise sub-program under SCE's Connections program.[104] LivingWise program savings are provided for the 2013-2015 program cycle, although the program was discontinued in June 2016.

WE&T Programs

In 2013-2015, IOUs spent their entire $96 million budget on WE&T activities, or 6 percent of total portfolio program expenditures. The WE&T program has a similar overall structure across the IOUs which has remained mostly unchanged since the 2010-2012 cycle. However, the program focus has evolved due to implementation of the California Workforce Education & Training Needs Assessment findings, sector

[102] California Public Utilities Commission, *California Long-Term Energy Efficiency Strategic Plan*. September 2008; p. 74
[103] Zabin, Carol and Chapple, Karen. *California Workforce Education and Training Needs Assessment*. Donald Vial Center on Employment in the Green Economy, University of California, Berkeley. 17 March 2011
[104] The LivingWise program was a sub-program within WE&T Connections. LivingWise was an education program which focused on elementary students. By participating in the program, students would receive an energy efficiency kit containing various electric, gas, and water measures - the savings claimed were a result of the number of kits provided.

strategies, and further CPUC guidance. The statewide program is organized into three subprograms: Centergies, Connections, and Planning.

The Centergies subprogram receives the majority of WE&T program funding, accounting for 72 percent of total program expenditures in the 2013-2015 program cycle. Centergies organizes training around technology categories (e.g. advanced lighting and HVAC), building type (e.g. commercial, residential) and focuses on facilitating education and training in energy efficiency and integrated demand-side management. These education and training services are primarily delivered through the IOUs statewide energy centers and via the Internet. The subprogram also facilitates and organizes trainings at dozens of locations throughout California. Depending on the IOU, an energy center may offer anywhere between 30 and 300 unique courses throughout the year.

The Connections sub-program focuses on forging collaborations with external education institutions to promote coordinated energy-related careers and training activities. In accordance with the Strategic Plan goal to "establish energy efficiency education and training at all levels of California's educational systems," the Connections subprogram works with primary education institutions, as well as secondary education-level institutions such as community colleges, community-based organizations, trade organizations, and universities. In the 2013-2015 program cycle, the Connections subprogram accounted for 25 percent of program cycle WE&T funds.

The Planning subprogram develops the statewide framework for planning, coordinating, and implementing WE&T activities, stakeholder engagement meetings, and partnerships. Across the IOUs, the Planning subprogram accounted for 3 percent of program cycle funds.

Highlights

The IOUs refocused their WE&T programs to respond to CPUC guidance and recommendations in the WE&T Guidance Plan. The Strategic Planning program completed the Guidance Plan in May 2014 and held a stakeholder engagement forum on the implementation of the recommendations. In addition, the IOUs focused on expanding trainings and training materials development in numerous areas including HVAC, lighting, and building operator capacities.

- Through the statewide HVAC sector strategy, IOUs refocused their HVAC trainings on quality installation/quality maintenance and energy efficiency sales trainings. Through the Energy Centers, the IOUS delivered QI/QM training for HVAC technicians, administered certification exams, and provided online training opportunities for contractors to access sales training and identify skills deficiencies.
- PG&E, SCE, and SDG&E also co-funded the California Advanced Lighting Controls Training Program in 2014. California Advanced Lighting Controls Program provides training on proper installation and testing practices to advance the use and installation of lighting controls in commercial facilities. In 2014 alone, they trained and certified 2,570 participants. [105]
- In 2015, the IOUs expanded collaborations with carpenters, stationary engineers, and sheet metal workers in order to enhance the energy efficiency components of these trades' training programs.

[105] Joint IOUs. *Joint IOU Workforce Education & Training Annual Report 2014*. Available at: https://www.caeecc.org/cross-cutting-workforce

These collaborations focused on WE&T-identified areas of opportunity including HVAC, Building Envelope, and whole building systems.[106]

Findings

Evaluations of the 2013-2015 workforce education & training program focused on studying implementation challenges associated with the recommendations from the WE&T Needs Assessment and guidance from CPUC Decisions 12-05-015 and 12-08-044, as well as data needs and collection methodologies for the WE&T program.

Data Needs and Collection:

Workforce education & training data needs comprised a major focus of the 2013-2015 program evaluation cycle.

The *WE&T Program Theory and Logic Model Update And Critical WE&T Data Needs* study found that Centers were inconsistent in their data tracking and collection efforts, but also found that much of the data collection required by CPUC guidance should be performed by the resource programs, not the WE&T teams. The study also found that program participants' information collection could be enhanced through course registration and course feedback surveys and that data tracking at the tool lending libraries is inconsistent.

The *Workforce Conditions Data Investigation* investigated the purpose, needs, and options for collecting workforce condition data from programs that are not in a direct contracting relationship with contractors in light of recent policy decisions (Decision 12-11-015) that asked for the IOUs to start collecting data on indirect contractors that could be costly and extensive. In many cases, employers did not have valid demographic data on their employees or on subcontractors' employees. Additionally, contractors expressed concern with providing sensitive wage and demographic data and requested clear and compelling arguments for why they should provide this data to the state.

The study also found that in order to support effective data collection, standardizing the definition of work quality across the IOUs and the coding of inspection failures may be necessary. As far as how to collect the data, the study found that electronic payroll tracking is the most valid and reliable method to acquire the demographic and wage information requested, but that this investment is not necessarily justifiable for all energy efficiency programs at this time.

Training Market Characterizations and Assessments:

In addition to data needs, evaluation efforts focused on characterizing the available trainings in the energy efficiency market.

The *WE&T Program Theory and Logic Model Update And Critical WE&T Data Needs* adjusted the program logic model to address new WE&T goals. The study found that the Centergies program allocated 45 percent of its activities to skills building and 55 percent of activities to market building. However, the study also found that additional policy and IOU input could be useful in determining the level of focus each of these areas deserves. The *Program Theory* study also had findings relevant to the CPUC and other policymakers, stating

[106] *Joint IOU Workforce Education & Training Annual Report 2015*. Available at: https://www.caeecc.org/cross-cutting-workforce

that the crosscutting nature of these programs has produced uncertainty on who is supposed to act on policy decisions related to WE&T.

The *Contractor Training Market Characterization* study investigated the alignment among resource program training requirements and WE&T courses, as well as the alignment between contractor training and IOU resource program requirements. It focused on the market for contractors that could support the following high-profile IOU resource programs:

- Residential Energy Upgrade California (EUC) Home Upgrade Program,
- Residential HVAC Program,
- Non-Residential Lighting Program.

Overall, the market characterization study found that existing trainings available in the state meet the training needs of contractors. However, the study also found that contractor awareness of these trainings and recognition of the value of these trainings is a gap that needs to be addressed.

In addition to the market characterization, an IOU-led *Lighting Controls Training Assessment* examined lighting controls installation training offered to installers by major lighting control manufacturers and by the California Advanced Lighting Controls Training Program. The study evaluated the California Advanced Lighting Controls Program and found that this training fills an important gap in the lighting controls installation area. However, the study also suggested the need for improvements in keeping training content and equipment boards up to date. The study also focused on developing a definition of work quality from which the impact of training programs can be assessed. This work on definitions could be useful in future studies, although the program administrators will still require some support to standardize the definition of work quality for energy efficiency installations.

Path to Statewide Goals

The SB 350 requirement to double energy efficiency will benefit tremendously from efforts to ensure that California has a qualified and trained energy workforce. Ensuring that energy efficiency measures are obtaining maximum energy savings through quality installation and that those savings are perpetuated through quality maintenance programs will support resource programs across the portfolio.

The investigations into data collection needs and limitations completed in the 2013-2015 evaluation cycle supports the development of efficient training and education programs for the energy workforce. While the data collection itself may eventually need to happen through the resource programs, the discussion surrounding workforce program data needs is a critical starting point. These study conclusions are already being discussed and incorporated into the discussions around how to target and measure progress within the workforce education & training Rolling Portfolio programs.

Marketing, Education, and Outreach

Overview

California has several policy objectives that require the voluntary actions of residents to achieve. Primarily, SB 350, the *Clean Energy and Pollution Reduction Act of 2015*, requires a doubling of energy efficiency savings in buildings by 2030. Statewide Marketing, Education, and Outreach (ME&O) is a tactic that is essential to getting customers to take energy savings and management actions. In addition, as the California utilities will be defaulting their customers to time of use rates in coming years, energy management concepts, and the message of "when you use energy matters," become important.

Statewide ME&O

While programs serving all customer segments include marketing as a tactic, the CPUC has focused the statewide ME&O platform on residential customers; consequently, this chapter is largely devoted to residential ME&O. The current brand, *Energy Upgrade California*, is the third brand since 2000, preceded by *Flex Your Power* and *Engage 360*. The program is designed to provide support and lead generation for PA programs, as well as non-PA activities such as behavior-change tactics (e.g. turning off lights), and substantial energy upgrades to the home such as solar installation. Evaluation of statewide ME&O, using the *Energy Upgrade California* brand name, was the focus of the report, "2013 – 2015 Statewide Marketing, Education, and Outreach Program: Integration and Verification Study."

Program Administrator ME&O

While statewide ME&O is a stand-alone program, it is designed to complement the program-level marketing that the PAs execute. Given that consumers are inundated with marketing messages, the CPUC recognizes the importance of coordinating the two levels of marketing—statewide and PA—in order to inspire action and avoid confusion. This is the subject of a second study, "2013-2015 California Statewide Marketing, Education, and Outreach Program: Cross-Cutting Process Study."

Estimated Savings

As Statewide ME&O is a non-resource program, there are no savings reported.

Marketing, Education, and Outreach Programs

Energy Upgrade California (EUC): Statewide ME&O was authorized for two years of funding in CPUC Decision D.13-12-038, and the Center for Sustainable Energy (CSE) was selected as the program implementer. A subsequent decision authorized a year of bridge funding for 2016. The program budget has been $23 million per year throughout. The Decision spelled out a unique governance structure wherein the program is overseen by the CPUC and run by the implementer CSE, but input is given by PAs. EUC was launched in spring of 2014. Because the authorization for Statewide ME&O comes from a separate proceeding than the energy efficiency proceeding (A.12-08-007), it is on a different program cycle than the traditional EE programs.

Highlights

Examples of the actions that EUC works to inspire include:

- Installing LED lightbulbs
- Washing clothes in cold water
- Buying energy efficient appliances
- Maintaining HVAC systems
- Unplugging unused devices
- Getting a whole home upgrade

CSE used several channels in its campaigns, including traditional tactics such as paid advertising and earned media (stories in the news media about energy conservation), as well as social media. In addition, CSE formed partnerships with community-based organizations in order to have an in-person presence at events. The creative concept behind EUC included a talking bear, simply named "Bear," who climbed down from the California flag to talk about energy conservation.

As part of the CPUC mandate, nine objectives were outlined for Statewide ME&O:

Table 21: Marketing, Education & Outreach Objectives

Marketing, Education, & Outreach Objectives	
1.	Use the Energy Upgrade California brand to educate consumers about the Home Upgrade programs, why energy use matters, and how California homes and small businesses use energy, as well as energy efficiency, demand response, distributed generation, and energy management actions available to them.
2.	Encourage consumers to engage with resources and tools to learn more about their energy use.
3.	Inform consumers about the benefits of participating in local program opportunities, seasonal opportunities, or no-/low-cost actions.
4.	Provide direction about how consumers can learn more about and enroll in local program opportunities and time-sensitive opportunities, or how to take no-/low-cost actions.
5.	Identify and pilot messaging and message delivery for partners that complements existing IOU partnerships, including local governments, CBOs, retailers, and realtors.
6.	Identify and pilot methods to provide information to small business owners.
7.	Work with a marketing firm and use behavior research to develop a social marketing campaign.
8.	Coordinate local, regional, and statewide marketing efforts, messaging, and tactics.
9.	Develop an evaluation, measurement, and verification (EM&V) roadmap for IOU local marketing and statewide marketing to understand the impacts of local, IOU-led marketing, and how local and statewide efforts can best be coordinated and complementary.

In conjunction with the objectives outlined for the Statewide ME&O program, the CPUC, CSE, and stakeholders participated in a process to develop specific metrics by which to judge performance of the program. The CPUC approved the metrics through the advice letter process, which provided final metrics in May 2015. Below are the metrics, their associated targets, and underlying rationale.

Figure 9: Summary of SW ME&O Objectives and Associated Objectives

Objective(s)	Metric	Target	Rationale
1, 3, 4	Awareness of Energy Upgrade California	20% aware (aided)	Demonstrates that consumers are familiar with Energy Upgrade California
1, 3, 4	Knowledge among IOU ratepayers who are aware of Energy Upgrade California of the specific actions and opportunities communicated by the initiative that they can take to better manage their energy use	25% can identify highlighted programs (aided)	Provides a sense of program or topic awareness among the general population either from SW ME&O or other sources
		25% can identify actions to save energy (unaided)	Gives an indication of whether consumers know how to save energy based on information either from SW ME&O or other sources
		25% know to go to the website to learn more (aided)[a]	Indicates that consumers know that EnergyUpgradeCA.org will provide them with information on energy management
2	Engagement with Energy Upgrade California website, digital media, social media, and community outreach	Website: 1.3 million unique visitors	Demonstrates potential audience for content
		Website: 25% of visitors view ≥3 pages or click on a link to an external site	Indicates that content is interesting enough for visitors to view multiple pages
		Website: 30% of visitors spend >5 sec on a page	Indicates that content is interesting enough that visitors spend some time on the website
		Social media: 40,000 Facebook fans	Demonstrates potential audience for content
		Digital media: 0.08% click through rate	Demonstrates immediate interest in program content
5	Participation in and engagement with Energy Upgrade California by CBOs, local governments, retailers, and realtors	Yes/No	Illustrates the use of partnerships to reach CA consumers
6	Small business messaging is researched and piloted	Yes/No	Demonstrates progress towards developing a small business outreach strategy
8	RENs and IOUs provide information to CSE and the marketing firm in a timely manner	Yes/No	Provides an indication of coordination between the various program administrators
9	EM&V roadmap for Energy Upgrade California is completed	Yes/No	Indicates a commitment and plan related to evaluation

Coordination and Integration with Other Efforts: Statewide ME&O is designed to complement the program-specific, regional marketing that is being implemented by the PAs. Thus, how EUC coordinates and integrates with the efforts of the PAs is of concern to Energy Division. PA ME&O efforts are embedded within existing demand-side management programs and work to support the achievement of program goals. Program marketing staff typically tailor their ME&O activities to first serve the immediate purpose of raising awareness of programs, but ultimately seek to encourage participation.

To examine the interaction between statewide and PA ME&O, the CPUC's Energy Division commissioned a study, "2013-2015 California Statewide Marketing, Education, and Outreach Program: Cross-Cutting Process Study." The study was led by Opinion Dynamics Corporation (ODC).

The evaluation team used a range of research activities to assess PA ME&O efforts including interviews with ME&O administrators and stakeholders, a review of secondary data and documents provided by the PAs, and quantitative surveys and qualitative focus groups with California consumers to support ODC's three research objectives. A brief synopsis of the research performed for each research objective below:

Assess coordination between the Statewide ME&O administrator and the PAs: ODC conducted a series of in-depth interviews with key stakeholders, and reviewed policy documentation and program materials to determine how efforts were coordinated across the ME&O administrators. The goals were to explore the barriers and benefits to developing and implementing a consumer referral process from the statewide website www.EnergyUpgradeCA.org to PA programs.

Document PA ME&O design and implementation activities: ODC reviewed PA data, conducted interviews with PA staff, and developed an activities matrix that catalogued all 2013-2014 ME&O activities for the California Statewide Programs for Residential Energy Efficiency (CALSPREE).

Document how consumers engage with Statewide and PA ME&O: ODC conducted primary data collection with California consumers including 10 focus groups and quantitative surveys for select ME&O campaigns conducted in early 2016. The evaluation team worked with the CPUC to select six campaigns out of 31 residential campaigns offered during the period.

Findings

Following are two sets of findings. The first one is from the "Verification and Integrated Effectiveness Study," which evaluated the program performance metrics that were set by the CPUC. The second is a cross cutting evaluation done of the statewide marketing brand and the IOUs marketing, and how they coordinated and leveraged each other. These summaries are followed by a discussion of future program design suggestions.

1. **Verification and Integrated Effectiveness Study:** Overall, the findings from this study provide a mixed picture of Statewide ME&O effectiveness. In terms of the formal program performance metrics established for the 2014-2015 period, CSE achieved four of the five metrics for which they are directly responsible based on data collected through September 2015.

Figure 10: SW ME&O Program Performance Against Approved Metrics

Metric	Description	Target	Actual Performance	Page Number	Data Source
1	Awareness of Energy Upgrade California	20% aware (aided)	20%	62	Wave 2 Tracking Survey
2	Knowledge among IOU ratepayers who are aware of Energy Upgrade California of the specific actions and opportunities communicated by the initiative that they can take to better manage their energy use	25% can identify highlighted programs (aided)	40% - 60%	71	Wave 2 Tracking Survey
		25% can identify actions to save energy (unaided)	67%	73	Wave 2 Tracking Survey
		25% know to go to the website to learn more (aided)[a]	43%	74	Wave 2 Tracking Survey
3	Engagement with Energy Upgrade California website, digital media, social media, and community outreach	Website: 1.3 million unique visitors	907,144	52	Program Material Review
		Website: 25% of visitors view ≥3 pages	21%	53	Program Material Review
		Website: 30% of visitors spend >5 sec on a page	35%	53	Program Material Review
		Social media: 40,000 Facebook fans	48,752	52	Program Material Review
		Digital media: 0.08% click through rate	0.11%	53	Program Material Review
4	Participation in and engagement with Energy Upgrade California by CBOs, local governments, retailers, and realtors	Yes/No	Yes - Achieved	41	Program Material Review
5	Small business messaging is researched and piloted	Yes/No	Yes - Achieved	38	Program Material Review
6	RENs and IOUs provide information to CSE and the marketing firm in a timely manner	Yes/No	Yes – Achieved by IOUs/RENs	50	Program Material Review
7	EM&V roadmap for Energy Upgrade California is completed	Yes/No	Yes – Achieved by CPUC	N/A	N/A

Beyond the performance metrics, the evaluation team identified the following key findings around campaign effectiveness and made associated recommendations for future Statewide ME&O Program implementation:

a. **Unaided Brand Awareness:** Californians struggle to name any energy-related brands without prompting, and unaided awareness of Energy Upgrade California remains low. In particular, only a handful of consumers named Energy Upgrade California when asked what brands, campaigns, or initiatives they had heard of that encourage Californians to save energy (1 percent in April 2015 and 2 percent in November 2015).

b. **Brand Familiarity and Knowledge:** First, while awareness of the Energy Upgrade California brand increased by only 3 percentage points since the brand assessment study in January 2013 (17 percent compared to 20 percent), those who are aware of the brand are somewhat more familiar with it. In particular, the average familiarity rating increased significantly from 3.09 in January 2013 to 4.11 in November 2015. Second, aided awareness of EnergyUpgradeCA.org among those aware of the brand increased significantly between April 2015 and November 2015 from 19 percent to 43 percent. These findings suggest a deepening of brand awareness among consumers as opposed to a broadening of awareness among a greater portion of the population.

c. **Energy Self-Efficacy:** An objective of the program is to empower Californians to better manage their energy use. As a result, the ODC evaluation team explored the degree to which consumers felt they were capable of managing their energy use. The ODC team found that consumers have moderate levels of energy self-efficacy (average scores of 4.7 to 5.0 on a scale from 1 to 7), which remained consistent over the course of 2015.

d. **Energy Saving Action:** In contrast to these advances on key measures of awareness, a deeper analysis of consumer engagement with and actions taken due to the program suggests that its effects on behavior are limited. In particular, the team assessed the performance of different community outreach channels (i.e., CBO, retail, and mobile outreach) at the center of CSE's move towards direct, one-on-one in-person engagements. ODC found that there was significant variation across the one-on-one outreach channels of retail, CBO, and mobile displays. ODC found that consumers had greater recall of retail and mobile events compared with CBO events and took a greater number of actions as a result of those engagements than those who engaged with CBOs.

2. Cross-Cutting Process Study

Research Objective 1: Assess coordination between the Statewide ME&O administrator and the PAs: Based on interviews with key stakeholders, the evaluation team found that coordination has improved over time, including increased two-way communication, more collaborative quarterly stakeholder meetings, and earlier opportunities to provide feedback on creative materials. Stakeholders, however, continue to identify challenges that need to be overcome moving forward. These include the separate ME&O planning processes, insufficient time or resources to provide feedback, and uncertainty about whether feedback is incorporated into Statewide ME&O design. Notably, many of these challenges may be alleviated by the development of Joint Consumer Action Plans.

Research Objective 2: Document PA ME&O design and implementation activities: PA ME&O differs from the SW ME&O program because Statewide ME&O focuses exclusively on promotion whereas PA marketing is rooted in all four elements of marketing (i.e., the Four Ps of product, price, place and promotion). Because the "action" that PA ME&O efforts seek to encourage is participation in marketed energy efficiency programs, they are distinct from Statewide ME&O efforts in the following ways:

- PA marketing reflects one of many strategies, such as rebates, that the PAs deploy to support program participation. For example, this study covered only PA promotional ME&O budgets, which reflect only 9 percent of overall CALSPREE 2013-2014 program administration budgets.
- PA marketing efforts are typically program-specific. The majority of PA ME&O funding is allocated to program-specific marketing efforts as opposed to general awareness or energy management efforts.

- PA marketing staff focus on developing marketing plans for key programs. According to the PAs, they tend to develop more comprehensive and targeted plans for programs with larger energy savings or participation goals, and rely on portfolio-wide plans to document strategies for programs with smaller energy savings or participation goals.
- PA ME&O efforts are regionally focused. The PAs conduct ME&O within their territories to deliver specific messages targeted toward their customers or constituents. Each PA has their own specific targeting and segmentation schemes that are tailored to specific programmatic efforts.

Having metrics in place is an essential component of measuring performance. The PAs develop and track a variety of program- and channel-specific metrics to assess the effectiveness of their activities. However, while all PAs indicate that they develop marketing plans as a key step in determining what ME&O activities to conduct, we found that their availability, the timing of their development, and their content varies across PAs, programs, and program cycles.

Research Objective 3: Document how consumers engage with Statewide and PA ME&O: ODC conducted six case studies of PA ME&O efforts - one for each PA. The following are overarching findings from across the case studies:

- Customers who have been exposed to program marketing tend to have moderate to high levels of program awareness and recall of marketing materials. As expected, levels of program awareness and recall vary widely across campaigns ranging from 13 percent to 92 percent of targeted customers.
- Customers generally report that they clearly understand the intended message from the marketing. However, results vary across the marketing campaigns likely due to the different messages and different levels of complexity associated with these messages.
- Customers exposed to the marketing campaigns tend to report that they have taken, or plan to take, intermediate or subsequent steps to participate or engage with the promoted program after exposure to the marketing.
- Compared to customers who did not recall marketing, those who recalled marketing were significantly more likely to have recently looked for more information online about the program (21 percent vs. 6 percent), to have discussed the program with someone in their household (25 percent vs. 14 percent), and to have contacted a contractor to learn more about the program (6 percent vs. 2 percent).
- In addition, customers who remember the marketing state that, on average, it had a moderate influence in their action taking – 48 percent of the respondents who recall the marketing and took at least one action in the past month noted that the marketing had some influence on their action.
- Overall, ODC's assessment indicates that the PA marketing campaigns appear to be achieving or on track to achieve their campaign objectives, such as increasing awareness of programs, providing clear messaging, and motivating energy savings actions.

Future Program Design: Based on the evaluation of 2013-2015 ME&O efforts at the SW and PA levels, the evaluation team recommends that the CPUC provide different levels of oversight for the SW ME&O program compared to PA ME&O efforts. The SW ME&O program focuses exclusively on promotion whereas PA marketing goes beyond promotion to include product, price, and place (i.e., the Four Ps).

Given this distinction, it does not make sense for the CPUC to provide oversight of only the promotional aspect of PA ME&O in isolation from the program(s) it supports. As a result, ODC has a number of recommendations to the CPUC regarding where, and how, to focus future oversight and guidance in the area of PA ME&O, listed in the next section.

Path to Statewide Goals

As statewide ME&O is a non-resource program, the energy saved from the program is not tracked. However, in 2016, the CPUC voted out D.16-03-029, which among other things details how Energy Upgrade California is expected to contribute to the SB350 goal of doubling building efficiency. The decision explains the role that Statewide MEO will play:

"To improve longer term planning and coordination, after the utilities file their energy efficiency business plans in R.13-11-005, all stakeholders in this proceeding should collaborate in a process to develop a five-year 'ME&O Strategic Roadmap' that will outline long-term goals, metrics, and strategies, with consideration of what contribution ME&O will play in complying with Senate Bill (SB) 350. CPUC staff shall lead this process. The roadmap should incorporate demand response ME&O objectives from R.13-09-011 as well as the strategic action plan for residential rate reform ME&O developed in R.12-06-013."

D.16-03-029 also ordered CPUC staff to work with the utilities to run a competitive RFP for a statewide ME&O implementer, which has been awarded to DDB-San Francisco (DDB). DDB has filed the 5 Year Strategic Roadmap with strategies that emphasize actions to reduce greenhouse gas emissions. That plan is currently being implemented.

Emerging Technologies

Overview

The Emerging Technologies Program (ETP) is a non-resource program. The mission of the ETP, as described in the Program Implementation Plans filed with the CPUC, is to support "increased energy efficiency market demand and technology supply (the term supply encompassing breadth, depth, and efficacy of product offerings) by contributing to development, assessment, and introduction of new and under-utilized energy efficiency (EE) measures (that is, technologies, practices, and tools), and by facilitating their adoption as measures supporting California's aggressive energy and demand savings goals." [107]

The 2013-2015 program cycle ETP budget was as follows:

Table 22: Emerging Technologies Program Budget by IOU

IOU	2013-2015 Program Budget (millions)
PG&E	$11.9
SCE	$21.2
SDG&E	$2.7
SCG	$2.5
TOTAL	$38.3

Three studies were conducted for ETP during the 2013-2015 program cycle: 2013-2014 Targeted Effectiveness Study, 2013-2014 Study of the California Utility Internal Measure Development Process (UIMD), and 2013-2014 Statewide Emerging Technologies Program Third Party Introduction Tactic Process Evaluation. A fourth study, the Technology Development Support Process Evaluation, is still ongoing. A fifth study, the 2015 Targeted Effectiveness Study, has been delayed until the ETP under the upcoming Energy Efficiency Rolling Portfolio Business Plans has been implemented long enough to enable meaningful evaluation.

The 2013-2014 Targeted Effectiveness evaluation results suggest that the IOUs met their Program Implementation Plan objectives and are contributing to both the EE portfolio and the broader Strategic Plan goals. However, poor data quality, poor data reporting, and a lack of market barrier support for technologies were identified as critical ETP issues.

Estimated Savings

The Emerging Technologies Program is a non-resource program, so no energy savings are attributed.

[107] The PIPs of each of the individual Investor-Owned Utility (IOU) submissions are virtually identical as this is a statewide program. The PIPs are located at: http://eestats.cpuc.ca.gov/

Emerging Technologies Programs

The Emerging Technologies Program focuses on the following program activities:

- **Technology Assessments** – Identify technologies suitable for transition into the portfolio by investigating performance claims. Technologies are evaluated based on their savings potential, cost, and alignment with statewide goals.
- **Technology Development Support** – This largely consists of communicating with manufacturers to encourage them to improve performance and efficiency specifications to produce higher efficiency products.
- **Technology Introduction Support** – Pathways for swifter introduction to market are explored, largely by connecting technology developers to manufacturers, investors, and other market actors. Demonstration projects are also included in this category.

Highlights

As in the 2010-2012 portfolio cycle, the program provided support to the IOUs' portfolio and the market in general. ETP met its program activity objectives while staying under budget. However, current data tracking systems and poor data quality hampered the ability to quantify savings from emerging technologies assessed by ETP in the EE portfolio. Despite limited data, the evaluations found that the ETP is contributing to the EE portfolio. The current suite of mapped measures from ETP projects adopted into the EE portfolio from 2010–2014 provides about 2 percent of the 2013–2014 statewide reported electric savings and slightly less therm savings.[108] Importantly, evaluations to date measure program success based upon the Program Performance Metrics and Program Implementation Plan objectives developed by the CPUC and IOUs to assess program effectiveness. These evaluations do not reflect the important role ETP plays by identifying technologies that are not appropriate for incorporation into the IOU EE portfolios.

Although ETP has succeeded in supporting workpapers for technologies such as cold storage, high performance commercial dishwashers, smart thermostats, advanced power strips, and advanced LEDs, the effectiveness of these technologies in achieving savings in the incentive portfolio has not been tracked. The 2013-2014 Targeted Effectiveness Study attempted to measure the impact of these technologies on portfolio energy savings. However, the study produced limited results as researchers were only able track about half of deemed measures installed. This study did prompt an effort to track the complete historical impact of ETP-originated technologies on the portfolio dating back to 2009, which is currently ongoing. Despite data limitations, the results from the 2013-2014 Targeted Effectiveness Study indicate that ETP is having at least some impact on the portfolio.

Findings

2013-2014 Targeted Effectiveness Study

This study took a holistic look at the effectiveness of the ETP, including deeper dives into the ETP database, ETP activities, and knowledge dissemination efforts, in addition to a separate memo on the difficulties of tracking savings of technologies that have moved into the IOU portfolio from the ETP. Overall, the ETP

[108] The evaluation was unable to map measure IDs to the EE portfolio database in all cases, leading to a likely underestimating of savings in the EE portfolio from ETP measures.

exceeded the activity goals, in terms of number of projects and events, which were set in its Program Implementation Plans while only spending half of its allocated budget.

In the 2013-2014 timeframe, the ETP was found to have provided technologies that contributed 2 percent of electricity savings achieved by the IOU portfolio and slightly less than 2 percent of therm savings. These percentages were calculated by matching ETP-originated projects to the achieved savings of IOU portfolio measures. However, this methodology encountered significant data quality barriers and, as such, could represent an underestimation of ETP's portfolio contributions. Efforts to improve program tracking data aim to solve this problem on a long-term basis and are currently underway.

The evaluation team found that ETP is a looked-to leader in its approach to assessing emerging technologies. They use a variety of tactics such as lab and field evaluation, demonstration showcases and test standard development. These tactics support a technology's "technical readiness," or its maturity level concerning its energy performance and feasibility, and "market readiness," or its maturity level concerning the marketplace's willingness and ability to adopt the technology. For emerging technologies to succeed once moved into the energy efficiency portfolio, they must be both technically ready as well as being available and acceptable to the market.

Evaluation results suggest that the ETP focuses on technical readiness. ETP effectively uses program tactics to support the decision for measure transfer based on "technical readiness" factors, such as technology and savings maturity. The ETP does an effective job at identifying these criteria and deploying appropriate tactics within this context.

This evaluation also found that the ETP could benefit from greater strategic focus when choosing tactics. Although ETP is seen as a leader on many emerging technologies studies, the evidence indicates that ETP may suffer from a lack of strategic focus when choosing projects to address barriers. The frequent appearance of "one-off" projects targeting a narrow technology context, the lack of clear relationships among projects within a technology, and the lack of explicitly sequenced projects all point to a less focused approach. This evaluation recommends a strategic technology-focused pilot to support a more holistic approach to tactic selection.[109]

2013-2014 Study of the California Utility Internal Measure Development Process (UIMD)

This study examined the technology input, evaluation, and energy efficiency measure output processes of the ETP. The technology identification and input process incorporates a wide range of coordination with other Technology Development Actors and technology consortiums. A wide range of IOU staff communicate internally and externally to identify technologies suitable for ETP evaluation and are actively searching for new ideas. However, uncertainty about data collection requirements for work papers, the mechanism through which new measures are accepted into the energy efficiency portfolio and assigned deemed energy savings values, has resulted in occasional requests by the IOU work paper teams for additional data after the completion of an ETP project. The ETP was also found to sometimes not produce sufficiently robust data to support work papers.[110]

[109] Op.cit.p.82
[110] *2013-2014 Study of the California Utility Internal Measure Development Process*, p.10-11

Although the study found ETP often provides insufficient data for workpaper development, ETP must balance conducting a wide range of shallow, less costly exploratory evaluations of potentially revolutionary, but risky, technologies with a smaller number of deeper, more costly evaluations of evolutionary technologies that could support a workpaper. This balance leads to a number of evaluations necessarily incapable of supporting workpapers without additional investigation by design. Discussions between the IOU ETP leads and the CPUC Ex-Ante Review team following this study show that there is not a lack of understanding of workpaper requirements in ETP evaluations, but rather that this balance merely gave that impression. Additional investigations into the optimal ratio of shallow to deep evaluations and improvements of how technology transfers between ETP and the portfolio are underway.

2013-2014 Statewide Emerging Technologies Program (ETP) Third Party Introduction Tactic Process Evaluation

This study examined the effectiveness of the ETP's Technology Resource Innovation Program (TRIP) and Innovative Design for Energy Efficiency Activities 365-days a year (IDEEA365) solicitation processes. These sub-programs provide a wide range of inputs to the ETP and access to third party technology developers. This study generally found the current processes to be sufficient to facilitate inclusion of third party technology developers into the ETP process, with minor recommendations for adjustments of the solicitation processes.

Path to Statewide Goals

Alignment of the ETP with statewide goals requires some programmatic changes to improve and maximize ETP's contribution to the portfolio. Without effective metrics that track ETP's impact on the portfolio, it is impossible to evaluate how well the program aligns with statewide goals or may contribute to the doubling of energy efficiency. Energy Divisions staff recommended new metrics, based on the recommendations from the 2013-2014 Targeted Effectiveness Study, in the Rolling Portfolio proceeding. To improve the market penetration of these technologies, Energy Division staff also proposed the Targeted Effectiveness Study's recommendation to initiate a technology-focused pilot for inclusion in the business plans. Additional efforts are underway to move the ETP database online in order to improve stakeholder access to ETP historical efforts, program direction, and program process framework.

Under the new Rolling Portfolio framework for energy efficiency, the ETP will become a statewide program, with SCE as the electric statewide lead and SCG as the gas statewide lead. This structural change will not significantly alter the implementation of ETP in practice, as the IOUs have historically coordinated very closely on ETP. However, statewide technology priority maps (TPMs) will be developed to guide the program as a whole, which is a significant departure from the previous roadmaps segmented by IOU that were used in the past to guide direction and coordination. The technology priority maps will identify priority technologies for assessment and broader program direction.

Local Government Partnerships

Overview

Local Government Partnerships (LGPs) have played an important role in promoting energy savings opportunities to municipal governments and organizations since 2002. Their role was formalized in 2002-2003 when the CPUC first allowed LGPs to received IOU contracts. Since then, the CPUC expanded funding of local government energy efficiency efforts across the four IOUs throughout the past three program cycles. In the 2010-2012 cycle, the CPUC made available significant funding resources for PG&E and SCE to promote Strategic Plan activities.[111]

The 2013-2015 program cycle marked a period of IOU expansion of LGP programs and growth in local agency capacity to deliver energy efficiency. PG&E increased emphasis on energy savings through small-medium-business direct install projects by leveraging the connections from its LGPs. SDG&E's five partnerships have collaborated closely to put forward a Regional Energy Partnership approach that promotes knowledge transfer among the local government partners and agencies without formal partnerships.

The four IOUs vary somewhat in how they operate their local government partnerships. PG&E has the most resource programs, or programs that directly produce energy savings, while SCG and SDG&E offer entirely non-resource programs, or programs that indirectly drive savings through supporting energy savings activities. SCE'S efforts have focused on retrofit activity for public buildings as resource programs. All four IOUs have some non-resource programs that address State Strategic Plan goals. The CPUC Energy Efficiency Policy Manual states that the LGPs are designed to:

1. Generate energy and demand savings within their own facilities and in their communities (retrofits)
2. Take actions [that] support the Strategic Plan objectives
3. Provide demand-side management outreach in the community

[111] California Public Utilities Commission. D.09-09-047 *Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets*. 09 September 2011.

Estimated Savings

Table 23: Local Government Partnerships Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	Gross	436	62	3	240	86	
	Net	324	46	3	179	65	0.9
Evaluated	Gross	396	58	3	216	76	
	Net	260	39	2	142	51	0.7
% Portfolio*	Gross	8%	6%	3%	3%	3%	
	Net	8%	6%	3%	3%	3%	

***represents sector's (or program area's) percent contribution to overall evaluated net portfolio savings, excluding Codes & Standards savings**

The LGPs account for 3 percent of the total energy efficiency savings goals for the entire portfolio for both electricity (GWh) and peak demand (MW), as well as 2 percent of the gas savings goals. However, the LGPs have not yet met their estimated savings program goals for either electricity or gas.

LGPs main purpose is to assist local governments in developing and implementing a variety of energy efficiency strategies that may lead directly or indirectly to energy savings. However, a majority of the estimated savings from these programs are allocated through the Program Administrators' activities (i.e. the IOUs) rather than linked directly to the specific LGP programs. Therefore, the savings attributed to these programs are estimates based on a larger study focusing on specific measure impacts, rather than from a stand-alone impact study focusing only on savings from the LGPs. The findings from this measure-level study are being updated for the next program cycle and will include estimated savings attributed to the LGPs as well.

Local Government Partnership Programs

The IOUS spent a total of $329 million on local government partnership programs across the 2013-2015 program cycle. These expenditures funded municipal retrofits (resource programs) and Strategic Plan Projects throughout California. Strategic Plan Projects are non-resource activities that the LGP implementers conduct to support achieving state goals for local governments. The IOUs' funding decisions are based on the Strategic Plan Menu, a list of 20 items approved by the CPUC. The CPUC intended for this funding to go toward non-resource activities within five categories:

- adopting reach codes
- supporting energy code compliance enforcement
- leading by example by reducing energy use in local government facilities
- supporting innovative programs, and

- Building expertise within local governments and communities.[112]

Highlights

The main categories of activities undertaken by LGPs can be divided into (1) municipal retrofit activity and (2) Strategic Plan Projects.

Municipal retrofit projects are often highly visible in local communities and are a point of pride among LGP representatives.[113] These projects replace old or inefficient equipment in public facilities and high-profile buildings. LGP representatives noted that these projects saved energy and provided additional community benefits. For instance, ten out of the 36 LGPs undertook projects to replace high-pressure sodium street lamps with LED technology. Benefits included saving energy but also improved aesthetics and increased perceived safety for pedestrians.[114] Of the 36 LGPs, five described two separate and distinct municipal retrofit projects as their main success, so in total there were 41 municipal retrofit success stories for 36 LGPs.

Strategic Plan Projects ran the gamut of activities, including but not limited to developing Climate Action Plans, conducting GHG inventories and code compliance training, and piloting water-energy programs. The Chula Vista LGP provides a clear example of successful Strategic Plan efforts. Chula Vista, with support from the LGP, designed and implemented a range of energy efficiency building codes and other reach codes that have pushed building stock in Chula Vista to an efficiency level beyond state building code and, in turn, helped advance stronger state codes. The Chula Vista LGP has developed and implemented code training efforts and produced resources such as the Code Coach to implement industry best practices in permitting, tracking, and building inspection.[115]

While the LGP programs had notable successes, evaluation studies also noted that local governments faced challenges in acquiring data, specifically to update greenhouse gas inventories. [116] Communication between IOUs and LGPs could also be improved, notably when updates to Title 24 could affect IOU rebate programs and other programmatic changes. [117]

Findings

Three specific EM&V studies were conducted to explore the status of operations of LGPs in selected areas. These studies were:

- *PY2013-2014 Local Government Partnerships Value and Effectiveness Study*, prepared by Opinion Dynamics Corporation, October 29, 2015 and managed by the CPUC Energy Division;
- *Targeted Process Evaluation of the Local Government Partnership Program*, prepared by Research into Action, September 30, 2016 and managed by the California IOUs; and

[112] Opinion Dynamics Corporation, PY2013-2014 Local Government Partnerships Value and Effectiveness Study Final Report. October 29, 2015; p.1
[113] Targeted Process Evaluation of the Local Government Partnership Program, prepared by Research into Action, September 30, 2016; p.46
[114] ibid
[115] Process Evaluation of the Chula Vista Local Government Program, prepared by Evergreen Economics, July 5, 2017; p.3
[116] Process Evaluation of the Association of Monterey Bay Area Governments Energy Watch (AMBAG) Local Government Partnership Program, September 17, 2017, prepared by Evergreen Economics (AMBAG Evaluation).
[117] Process Evaluation of the Chula Vista Local Partnership Program, CALMAC ID: SCG0218.01, July 5, 2017, prepared by Evergreen Economics; and San Mateo Evaluation.

- *Process Evaluation of the Chula Vista Local Government Program*, prepared by Evergreen Economics, July 5, 2017 and managed by the California IOUs.

The *Local Government Partnerships Value and Effectiveness Study* focused on one specific program offering: the value and effectiveness of Strategic Plan Projects. Strategic Plans enable local governments to set long-range energy goals for their communities and chart a course to achieve them. This is a crucial element to support the overall Strategic Plan objectives.

The second process evaluation, the *Targeted Process Evaluation of the Local Government Partnership Program,* examined the Strategic Plan support and municipal retrofit components of the LGP program and was managed by the California IOUs.

The third process evaluation report provided an in-depth examination of the Chula Vista's LGP. The Chula Vista LGP serves Chula Vista, a city with a long history of leadership in energy efficiency and conservation. Historically, the Chula Vista LGP has been a highly successful regional leader in promoting energy efficiency activities that indirectly contribute to SDG&E's energy efficiency Core Programs. [118] The process evaluation found numerous examples of the ways in which this LGP is effectively assisting the IOU on completing energy efficiency retrofits for municipal buildings.

Strategic Plan Projects

As of July 2015, evaluation results of activities from 2013 and 2014 found that 33 percent of all projects were successfully completed. Many others (46 percent of all projects) are still in progress with completion likely. Completed project efforts include workshops, trainings, and engagement of local government decision makers, code inspectors, and plan checkers. Strategic Plan Projects have not fully met their Strategic Plan goals, but much of the effort is still in progress.[119]

The *Value and Effectiveness Study* also confirmed that the majority (83 percent) of LGPs conduct Strategic Plan Projects. However, the projects and funding levels are highest in southern California and along the coast, reflecting the state's population density patterns.[120] From 2010-2014, there have been 389 Strategic Plan Projects. The study found that these projects are providing high value to California. The funding for the projects provides the means (i.e., people, knowledge, and tools) to the LGs to develop policies that align with and support Strategic Plan goals. However, while all projects align with broad Strategic Plan goals, the study found that 15 percent do not meet the guidelines for Strategic Plan Projects.[121]

Municipal Retrofits

Local Government Partnerships exhibited a variety of municipal retrofit activities. In one example, the Chula Vista LGP exceeded its Climate Action Plan goals for energy efficiency improvements in municipal buildings. Municipal retrofits encouraged through Chula Vista's LGP resulted in a reported reduction in energy

[118] Process Evaluation of the Chula Vista Local Government Program, prepared by Evergreen Economics, July 5, 2017; pp. 3-6
[119] PY2013-2014 Local Government Partnerships Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, October 29, 2015; p.2
[120] PY2013-2014 Local Government Partnerships Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, October 29, 2015; p.3
[121] PY2013-2014 Local Government Partnerships Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, October 29, 2015; p.1

consumption of over 29 percent compared with 2010 consumption levels. This exceeds the goal of a 20 percent reduction by 2020 from 2010 levels as set in the Chula Vista Climate Action Plan.[122]

Another example found that these municipal retrofits have also led to both energy savings and non-energy benefits. One LGP representative from an urban partnership found that the municipal retrofit conversion from high-pressure sodium streetlights to LED streetlights did more than save energy. The LGP received police department feedback that the new LED lighting was improving working conditions for its officers because the new lamps better lit the sidewalks, creating greater visibility for police officers walking the neighborhoods at night and contributing to a greater sense of safety. The LGP representative also noted that crime had dropped in the neighborhoods with the new streetlights, perhaps due to increased foot patrols by police.[123]

Program Operations

The IOUs take different approaches to LGP programs. PG&E's implementation model emphasizes the Direct Install activities, SCE and SCG's program model emphasizes municipal retrofits, while SDG&E focuses on regional planning among its partnerships. Additionally, PG&E's Strategic Energy Resources funding component allows greater flexibility in the partnership's choice of activities contributing to the Strategic Plan. SCE offers its partnerships a tiered incentive structure that rewards greater achievements with enhanced incentive payments for each kWh saved.[124]

The Chula Vista LGP demonstrates important leadership in the region, as well as nationwide, developing and enacting energy best practices related to municipal building stock and community outreach. Chula Vista staff engage extensively with other communities to share its expertise, both locally through the South Bay Energy Action Collaborative, San Diego Regional Energy Partnership, and San Diego Association of Governments partnerships, and nationally and internationally through participation in conferences and energy efficiency competitions.

Challenges with LGP Program Design

The LGP program design is complex and presents a steep learning curve for local governments, implementers, and program staff alike. Partnership representatives report complex administrative barriers to completing LGP work. [125] While the IOUs are providing technical assistance to help reduce the internal barriers that local governments face in completing Strategic Plan Projects, the IOU administrative structure remains challenging.[126]

In addition, partnerships in geographically isolated areas continue to experience marketplace barriers in spite of ongoing attention to this group in the northern part of the state. These marketplace barriers include a lack of trained local contractors to perform energy efficiency retrofit work, difficulty attracting out-of-area contractors, and a lack of energy efficient equipment available locally for comprehensive retrofits. In

[122] *Process Evaluation of the Chula Vista Local Government Program*, prepared by Evergreen Economics, July 5, 2017; p.3
[123] *Targeted Process Evaluation of the Local Government Partnership Program*, prepared by Research into Action, September 30, 2016; p.46
[124] *Targeted Process Evaluation of the Local Government Partnership Program*, prepared by Research into Action, September 30, 2016; p.11
[125] Page II through Page V, Targeted Process Evaluation of the Local Government Partnership Program, prepared by Research into Action, September 30, 2016.
[126] Page 1, PY2013-2014 Local Government Partnerships Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, October 29, 2015.

addition, the existing working group (the RHTR Working Group) serves some, but not all, of these partnerships. [127]

Path to Statewide Goals

Variation in the IOU approaches to their LGPs came about in part from the 15-year evolution of the LGPs within separate IOU territories. The four distinct IOU LGP models, namely the mix between resource and non-resource programs, may allow increased ability to respond to local conditions, but such variation complicates regulatory oversight and makes the task of program evaluation difficult. In response, CPUC Decision 16-08-019 clearly signaled a call for change in the way the IOUs administer their LGPs, directing that "all business plans should also include strategies for improving the consistency of LGP administration statewide."[128] The CPUC is currently considering future LGP direction in the energy efficiency business plan proceeding (R.13-11-005).

[127] Page II through Page V, Targeted Process Evaluation of the Local Government Partnership Program, prepared by Research into Action, September 30, 2016.

[128] CPUC, D.16-08-019 *Guidance for Initial Energy Efficiency Rolling Portfolio Business Plan Filings.* Findings of Law, No. 53, p. 104, August 18, 2016,

Regional Energy Networks & Community Choice Aggregators

Overview

The CPUC authorized new types of energy efficiency program administrators in November 2012, through the formation of two Regional Energy Networks (RENs) and Marin Clean Energy (MCE), a Community Choice Aggregator (CCA).[129] With a two-year budget of $87 million, the RENs account for 3 percent of California's 2013–2015 energy efficiency portfolio budget of $2.6 billion, while MCE was allocated a little over $4 million for the same period.

The RENs are independent of the IOUs, but are supported by ratepayer funds. They were approved to deliver energy efficiency services according to the following criteria:

- Activities that the IOUs cannot or do not intend to undertake;
- Activities for which there is no current IOU program offering and for which there is the potential for scalability to a broader geographic reach, if successful and;
- Activities in hard-to-reach markets, whether or not there is currently a IOU program that may overlap.[130]

The two RENs formed in 2012 are Bay Area Regional Energy Network (BayREN), which serves nine counties in the San Francisco Bay Area, and Southern California Regional Energy Network (SoCalREN), which serves six full counties in southern California, as well as parts of five other counties.

Marin Clean Energy is California's first Community Choice Aggregator, and is the only CCA that administers ratepayer-funded energy efficiency programs. MCE first began serving residents and businesses in the Marin County and has since expanded to serve Napa County and the Cities of Richmond, Benicia, El Cerrito, San Pablo, Walnut Creek, and Lafayette. As a CCA, MCE can purchase power on behalf of its customers and provide access to energy efficiency programs.

[129] D.12-05-015, "Decision Providing Guidance on 2013-2014 Energy Efficiency Portfolios and 2012 Marketing, Education, and Outreach" Date of Issuance: 18 May 2012; and D.12-11-015: *Decision Approving 2013-2014 Energy Efficiency Programs and Budgets*. 15 November 2012

[130] D.12-11-015: *Decision Approving 2013-2014 Energy Efficiency Programs and Budgets*. 15 November 2012; p.17

Estimated Savings

Table 24: RENs and CCAs Savings Snapshot

		Energy Savings			Emissions		Cost-Effectiveness
		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)	CO_2 (Million Tons)	NOx (1000 pounds)	TRC
Reported	**Gross**	12	3.4	0.8	9.8	7.7	
	Net	10	3.0	0.7	8.6	6.9	0.29
Evaluated	**Gross**	4.4	0.8	0.5	4.2	4.2	
	Net	3.6	0.7	0.4	3.6	3.6	0.10
% Portfolio (Evaluated)	**Gross**	0.1%	0.1%	0.5%	0.1%	0.2%	
	Net	0.1%	0.1%	0.6%	0.1%	0.2%	

Neither the RENs nor MCE are meeting their estimated savings goals based on the findings from the most recently completed impact evaluation for the 2013-2015 program cycle.

The RENs resource program savings come from the residential sector while MCE's energy savings come from both residential and commercial energy efficiency upgrades. The two RENs offer the Single Family Home Upgrade and Multifamily Whole Building programs, both of which are whole building retrofit programs with a suite of measures. BayREN has a code compliance program, while SoCalREN has public sector program that helps municipal governments undertake retrofits.

The MCE program offers a wide variety of energy efficiency measures in both the residential and nonresidential sectors. Ninety-one percent of the MCE program's reported electric savings are in the nonresidential sector, 82 percent of which are focused on nonresidential lighting. MCE's reported gas savings mostly come from residential faucet aerators and showerheads, which comprise 69 percent of the reported savings.[131]

BayREN and SoCalREN's current ex-ante savings values for multifamily measures are not considered reliable based on the ex-ante savings review. The net-to-gross ratios for BayREN's multifamily measures are significantly lower than ex ante estimates.

Overall, the reported savings for MCE's small commercial and multifamily measures are less than reported savings but not much lower than what is typically found in CPUC evaluations of similar IOU programs. MCE's net-to-gross ratios are consistent with net-to-gross ratios for similar IOU programs.[132]

[131] 2013-14 Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report, Itron, Apex Analytics & DNV-GL, January 8, 2016. Page ES-3
[132] 2013-14 Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report, Itron, Apex Analytics & DNV-GL, January 8, 2016. Page ES-17

Overview of Non-IOU Programs

Bay Area Regional Energy Network

- BayREN Single Family Home Upgrade is a service available to owners of single-family detached homes in the BayREN territory who are PG&E customers. This program pays incentives for whole house retrofits and offers assistance to customers and contractors going through the process through its Home Upgrade Advisor segment.
- Bay Area Multifamily Whole Building Program is a service that allows multifamily property owners to receive free technical assistance designed to lower barriers to multiple measure upgrades through technical and financing assistance. Property owners receive customized scopes of work designed to reduce building energy use and receive incentives for whole building retrofits and for indoor LED lighting.
- The BayREN Codes and Standards Subprogram consists of three components: enforcement of existing codes, training, and sharing best practices for reach codes.
- The BayREN Energy Efficiency Financing Portfolio contains three programs to help make energy efficiency upgrades more affordable. The components are: (1) Pay as You Save, (2) Commercial PACE, and (3) Multifamily Capital Advance.

Southern California Regional Energy Network

- Single Family Home Upgrade, Multifamily Whole Building retrofits, Local Marketing and Outreach, Contractor Outreach and Training, Green Building Labeling, and Low Income Single Family Housing Upgrades. Through the Single Family Home Upgrade and Multifamily Whole Building program components, SoCalREN provides incentives for both single family and multifamily whole house/building retrofits.
- Financing programs are made available by SoCalREN to local governments to supplement the on-bill financing offered by the IOUs and, therefore, enable greater investments in deep energy savings.
- SoCalREN's Regional Energy Center offers comprehensive technical support to local governments and other public entities to enable them to implement deeper and more cost- effective energy management practices.[133]

Marin Clean Energy

- The MCE Multifamily Program is designed to reduce barriers to retrofits by providing technical assistance and incentives to multifamily property owners. Incentives are offered for window film, CFLs, linear fluorescents, LEDs, pipe insulation, and a variety of domestic hot water measures.
- The MCE Small Commercial Program is a multiple measure program for small commercial high-energy use segments. The program reduces barriers to retrofits by providing technical assistance and incentives to building owners. Incentives are offered for CFLs, occupancy sensors, LEDs, linear fluorescents, delamping of linear fluorescents, and selected refrigeration measures.
- The MCE Single Family Program enables energy and water savings with associated cost reductions through behavior changes, upgrading of appliances and water conservation measures that affect

[133] 2013-14 Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report, Itron, Apex Analytics & DNV-GL January 8, 2016. Pages ES-2-ES-3,

energy. Program activities include encouraging customers to register for the online My Energy Tool and sending out Home Utility Reports. No measures are rebated under this program.

- The MCE Finance Pilots Program includes two innovative finance programs to ensure that retrofits are financially competitive and accessible to a broader and more diverse range of property owners. The two financing program elements are On-Bill Repayment and a Standard Offer Energy Efficiency pilot.[134]

Highlights

Despite their relatively nascent status at the beginning of this program cycle, the RENs successfully navigated the CPUC regulatory environment and mitigated administrative challenges to bring their $67 million dollar portfolio of programs to fruition within 18 months. Through their Multifamily programs, the two RENs cumulatively implemented 246 projects during 2013-2015, representing over 18,000 dwelling units.[135] The BayREN Multifamily program made significant progress relative to its forecasted goals for both its electricity and gas savings projections. This program offers rebates and no-cost energy consulting for multifamily properties that undertake energy and water upgrades.

MCE improved the performance of its Home Utility Reports program over the course of the program cycle until it was on par with savings from similar behavior programs.

Multiple evaluation studies found that both RENs and MCE needed to improve their data reporting and data quality, in order to properly assess their programs. As detailed in the *Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report*, these three PAs must improve accuracy of program tracking data and expenditure data in order to support accurate cost-effectiveness calculations and program assessment.

[134] 2013-2014 Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report, Itron, Apex Analytics & DNV-GL, January 8, 2016. Page E-1

[135] *2013-2015 REN Multifamily Program Impact Evaluation,* prepared by Itron, 20 June 2017 p. ES-4

Table 25: Subprograms Included in the EM&V Studies[136]

Subprogram	Areas Addressed in the ODC Report	Areas Addressed in the Itron Report
BayREN Programs		
Single Family Home Energy Advisor	Assess Value and Effectiveness; Summary of Accomplishments	Gross Impact Assessment, Cost Effectiveness Analysis; Evaluability Assessment; Accomplishments Assessment
Multifamily	Assess Value and Effectiveness; Summary of Accomplishments	Gross Impact Assessment, Net-to-Gross Analysis; Cost Effectiveness Analysis, Evaluability Assessment; Accomplishments Assessment
Codes & Standards	Summary of Accomplishments	Not evaluated
Financing Portfolio	Assess Value and Effectiveness of PAYS Water Efficiency Pilot; Summary Accomplishments	Not evaluated
SoCalREN Programs		
Single Family Home Upgrade and Multifamily Whole Building	Summary of Accomplishments	Gross Impact Assessment, Cost Effectiveness Analysis; Evaluability Assessment; Accomplishments Assessment
Financing	Assess Value and Effectiveness of Public Agency Financing Program; Summary of Accomplishments	Not evaluated
SoCalREC	Summary of Accomplishments	Evaluability Assessment; Accomplishments Assessment
Marin Clean Energy		
MCE Multifamily Program	Not Addressed	Gross Impact Assessment, Cost Effectiveness Analysis; Evaluability Assessment; Accomplishments Assessment
MCE Small Commercial Program	Not Addressed	Gross Impact Assessment, Net-to-Gross Analysis; Cost Effectiveness Analysis; Evaluability Assessment; Accomplishments Assessment
Single Family Program	Not Addressed	Evaluability Assessment; Accomplishments Assessment
Financing Program	Not Addressed	Not Evaluated

Findings

During the 2013-2015 program cycle, CPUC staff commissioned and oversaw two studies designed to assess the RENs' progress, one joint REN and CCA study, and two impact evaluations on MCE's Home Utility Reports program:

[136] Pages 17-23, PY2013-2014 Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, January 6, 2016, and Page ES-4, 2013-14 Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report, Itron, Apex Analytics & DNV-GL, January 8, 2016.

- *The PY 2013–2014 Regional Energy Networks Value and Effectiveness Study* (Value and Effectiveness Study") Final Report, conducted by Opinion Dynamics Corporation (ODC), January 6, 2016
- *2013-2015 Regional Energy Networks Multifamily Programs Impact Evaluation*, prepared by Itron and Apex Analytics, June 30, 2017
- *2013-14 Regional Energy Networks and Community Choice Aggregator Programs Impact Assessment Final Report* (Impact Assessment)**,** prepared by Itron, Apex Analytics and DNV-GL January 8, 2016
- *Impact Evaluation of 2014 Marin Clean Energy Home Utility Report Program,* prepared by DNV-GL, 1 April 2016
- *Impact Evaluation of 2015 Marin Clean Energy Home Utility Report Program,* prepared by DNV-GL, 5 May 2017

The two studies focused on the 2013-2014 period were intended to determine the overall effectiveness of the RENs and MCE and the savings impacts they have contributed during the 2013-2014 program period. However, both studies were reduced in scope based upon the available data, budget, and completion dates. Thus, rather than providing a comprehensive assessment of the program operations and savings impacts, the studies provide a qualitative assessment of some REN and MCE programs in the 2013-2014 program years and a verification of savings estimates for a subset of REN and MCE programs. [137]

One aspect to consider when evaluating both the RENs and MCE is that the programs they implement are typically aimed at serving hard-to-reach customer segments. All three PAs have a program focused on the multifamily sector, which has been indentified as a hard-to-reach segment, while MCE also has a small commercial program serving the hard-to-reach small commercial market.

Regional Energy Networks

The *Impact Assessment* found that, for REN program performance to be accurately assessed, the RENs need to significantly improve the accuracy and reliability of their reported savings claims and program expenditures.

The *Value and Effectiveness Study* found that the RENs successfully surmounted significant barriers to entry and gained proficiency within the complex energy efficiency regulatory environment. When faced with delays in CPUC decision making and funding, the RENs took stock, made adjustments, and responded to mitigate the late start and to advance their goals in a responsive manner.

For example, SoCalREN explained that they cut some non-resource activities in order to meet resource activity goals under a constrained timeframe. To help with the multiple regulatory requirements, the Association of Bay Area Governments (the lead agency for BayREN) added an assistant to manage most regulatory processes for BayREN.[138]

The *Value and Effectiveness Study* also identified several additional benefits from the REN program offerings.

[137] Pages 2 and 9, Draft EM&V Plan, ODC, September 18, 2014 explained that the effectiveness component of the study would assess the RENs' management capabilities with emphasis on both non-resource activities and innovative sub-pilots. The justification to include only non-resource pilots is two-fold. First, resource pilots would be evaluated under the impact evaluation, and second, budgetary constraints for the process evaluation necessitate that the overall scope of the evaluation be narrow. The number of RENs programs evaluated with any rigor was reduced to three via a two-part process. First, Energy Division identified RENs' programs that could be evaluated within planned related program studies under a program lead analyst (e.g., Financing and Codes and Standards). The remainder (e.g., SoCalREC) had evaluability challenges that disqualified them from a more rigorous review (i.e., lack of program track record and corresponding data and being non-resource programs).

[138]PY2013-2014 Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, January 6, 2016. Page 3

For example, the RENs unveiled to the California EE community two new programs in the 2013-2014 program cycle that, although presently non-resource programs, hold potential to contribute to states energy savings goals: Pay as You Save and two Southern California Regional Energy Center software packages.139

Marin Clean Energy

As with the RENs, the *Value and Effectiveness Study* found that MCE needed to improve the accuracy and reliability of their reported savings claims and program expenditures data. The study found that the gross assessment on MCE's small commercial and multifamily measures indicate that reported lifecycle gross savings were overestimated. However, the study did find that the net-to-gross ratio for MCE's small commercial program was comparable to other similar programs.[140]

An impact evaluation of MCE's Home Utility Reports found that the program did not achieve any detectable electric savings during 2013-2014. As described in the evaluation study, "the success of a behavioral program is driven by the effectiveness of the reports and the willingness and ability of the targeted populations to decrease their energy consumption. Any of these factors, individually or in combination, could explain the lack of response to the HUR program."[141] This program was evaluated again for the 2015 program year, in which the program improved to provide savings in line with the 1 percent to 3 percent savings produced by other behavioral programs. [142]

[139] PY2013-2014 Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, January 6, 2016. P.1
[140] PY2013-2014 Value and Effectiveness Study Final Report, Opinion Dynamics Corporation, January 6, 2016. P. ES-19
[141] DNV-GL, *Impact Evaluation of 2014 Marin Clean Energy Home Utility Report Program,* 1 April 2016, p. 3
[142] DNV-GL, *Impact Evaluation of 2015 Marin Clean Energy Home Utility Report Program*, 5 May 2017, p. 3

Finance

Overview

Financing is an important tool for California to meet its energy efficiency goals, as these programs can support the removal of up-front cost barriers for energy efficiency measures. The 2013-2015 Statewide Financing Program consisted of a portfolio of financing efforts, including continuation of the On-Bill Financing (OBF) program, continuation of the American Recovery and Reinvestment Act (ARRA)-originated financing programs, and a set of new financing pilots for single-family and multi- family residential customers, as well as for small business and broader non-residential customers.

OBF and the new financing pilots were statewide efforts by the IOUs, whereas the ARRA-originated programs were implemented regionally. These financing offerings were intended to eventually support all types of demand-side investments, including energy efficiency, demand response, distributed generation, and storage. The total statewide financing budget for IOU programs in the 2013-2015 cycle was $189 million. An additional $110 million was allocated for REN and CCA financing programs.

For the 2013-2014 portion of the program cycle, the IOUs' financing program budget totaled $154 million, which represented slightly less than 10 percent of the total budget for the 2013-14 program cycle. The total program budget for 2015 was $34 million. Additional portfolio funds were allocated to the RENs' and MCE's finance pilots in the amount of $62 million for 2013-2014 and $47 million for 2015.

Estimated Savings

Financing programs are currently being treated as non-resource programs. The CPUC is exploring the possibility of attributing savings to financing programs, but the methodology to do so has not been defined yet. As such, no savings have been reported in the 2013-2015 program cycle.[143]

Energy Efficiency Financing Programs

Decision 13-09-044 initiated the Statewide Finance Pilots. The following Program Implementation Plans (PIPs) are further defined in this Decision:

[143] In applications for the 2013-2014 program cycle, the CPUC ordered the IOUs to, "address their strategy for maximizing portfolio cost-effectiveness by offering financing programs in coordination with rebate/incentive programs, either by offering financing in lieu of rebates and/or by lower incentives in cases where financing is also provided." The connection to savings attributions has not been finalized for financing programs at this time.

The ARRA-originated programs include:

ARRA-originated Finance Programs	
PG&E	• Golden State Financing Authority (Formerly the California Homebuyers Fund) – Loan Loss Reserves for Single Family • emPower Central Coast – Loan Loss Reserves for Single Family
SCE	• emPower Central Coast – Loan Loss Reserves for Single Family
SDG&E	• CCSE Marketing
SCG	• emPower Central Coast – Loan Loss Reserves for Single Family

The regional finance pilots administered by RENs and CCA include the following:

Regional Finance Pilots Administered by RENs and CCAs	
SoCalREN	• Energy Upgrade California Residential Loan Loss Reserve (Single Family LLR)* • Non-Residential PACE: Promotion and administration for already established PACE program that uses private funding backed by LA County bonds* • Promotion and management of master lease program (Public Building LLR)* • Promotion of public agencies of finance programs and assistance setting up revolving loan fund (Public Agency Loan Fund)*
BayREN	• Multi-Family Capital Advance Program Pilot - Supports Energy Upgrade California • Commercial PACE - Supports commercial PACE in the Bay Area • Pay As You Save*
Marin Clean Energy (MCE)	• On-Bill Repayment for Single Family (LLR) • On Bill Repayment for Multi-Family and Small Commercial (LLR) • Standard Offer Finance Program- Designed for the Commercial and Agricultural sectors

***ARRA-originated**

D. 13-09-044 allocated a total of $75.2 million to finance the pilots over the initial pilot period. The funding for these Statewide Pilot Programs was delayed until July 2014 as the ability of the implementer, the California Alternative Energy and Advanced Transportation Finance Authority (CAEATFA) to use the funds had to be authorized through the annual state budgeting cycle and key systems had to be established and interconnected before program implementation could begin.

The Residential Energy Efficiency Loan is the first energy efficiency financing pilot program with its first enrolled loan in July 2016. The Residential Energy Efficiency Loan pilot program uses ratepayer funds to leverage private finance through credit. This new approach seeks to allow the scale of financing of energy efficiency in California to grow beyond what ratepayers can fund directly, as well as to expand the availability of financing to residential that are currently unable to access such funds. As of March 31, 2017, the Residential Energy Efficiency Loan program has 11 enrolled loans. [144] Other pilots are still under

[144] As of the September 22, 2017, there are 65 loans and total amount of loans reached $ one million dollars. http://www.treasurer.ca.gov/caeatfa/cheef/resources.asp.

development and plan to launch in 2017 or beyond. The Decision 17.03-026 addressing energy efficiency financing pilot programs originally ordered in Decision 13-09-034 ordered CAEATFA to cancel any financing pilot program that is not launched by December 31, 2019.

In the OBF program, eligible customers applying for energy efficiency program rebates or incentives can finance the balance of their project costs using an OBF loan at zero percent interest. Loan installments are then included as a line item on the utility bill. Minimum loans are $5,000 and the maximum loan varies by customer type and IOU. OBF loans are designed to be bill neutral, meaning that monthly payments are not expected to exceed projected monthly energy savings. Loan terms are calculated using the total project cost and the projected monthly energy savings, with a maximum term of five years for commercial, industrial and agricultural customers, and 10 years for taxpayer-funded institutions.

On-bill financing is a revolving loan pool.[145] With OBF, as loans are repaid on a monthly basis, the IOUs are able to commit to and make additional loans using the loan pool. Table 28 shows that the total statewide-authorized loan pool was $158.6 million by the end of 2015. PG&E has issued the most loans since program inception and SCG had the smallest share.

[145] SCE's loan pool operates as revolving loan pool within each program cycle. The other IOUs' loan pools revolve across program cycles. Unspent, uncommitted OBF funds will be returned to ratepayers at the end of each program cycle by SCE, and at the time of authorized termination of OBF by the other IOUs.

Table 26: On-Bill Financing Loan fund Activities from Program Inception to December 31, 2015[146]

	Authorized Loan Funds	Loan Amount Issued	Loan Amount Repaid	Outstanding Loan Balance	Committed/ Reserved Loan Amounts[147]	Size of Available Loan Pool[148] [149]
	(a)	(b)	(c)	(d)	(e)	(f)
PG&E	$60,500,000	$59,165,315	$24,842,186	$34,323,129	$15,641,704	$10,535,167
SCE	$66,663,529	$45,909,365	$21,467,326	$24,442,040	$37,826,335	$4,395,154
SDG&E	$26,002,565	$48,767,117	$35,929,571	$12,837,546	$2,491,952	$10,673,068
SCG	$5,500,000	$2,818,855	$1,887,292	$931,563	$698,017	$4,600,179
Statewide	$158,666,094	$156,660,652	$84,126,375	$72,534,278	$56,658,008	$30,203,568

Definition of Column Headers:

Col (a), Authorized Loan Funds: Cumulative amount of ratepayer dollars authorized by the CPUC to fund OBF loans from program inception through year 2015.

Col (b), Loan Amount Issued: Cumulative amount of loans issued since program inception through year 2014.

Col (c), Loan Amount Repaid: Cumulative amount of loan repayments by OBF customers from program inception through year 2014.

Col (d), Outstanding Loan Balance: Cumulative loan amount that is expected, as of 12/31/14, to be paid back by OBF customers.

Col (e), Committed/Reserved Loan Amounts: Amount of committed/reserved funds as of 12/31/14 for pending OBF Applications.

Col (f), Size of Available Loan Pool: Funds available for new loans as of 12/31/14. This amount is continually being modified by factors such as interests accrued on the loan pool balance, loan repayments credited to the loan pool, new loans reserved/committed, and for PG&E/SCE, new charge offs of defaulted loans.

More loans, both in terms of number of loans and amount of loans, were issued in 2014 than in 2013 or 2015. However, the average loan size was the lowest in 2014 than the year before or after, as shown in Table 29. Additionally, Table 30 shows that more than half of loan amounts (54 percent) were made to the commercial sector followed by institutional (39 percent) sector.

Table 27: OBF Loans Issued Statewide

OBF Loans Issued Statewide, 2013-2015	2013	2014	2015	2013-2015
# Loans Made	834	1,330	623	2,787
Total Amt. Loaned	$34,480,292	$41,671,050	$30,811,508	$106,962,850
Avg. Loan Amt.	$41,343	$31,332	$49,457	$38,379

[146] SDG&E's and SCG' OBF programs were launched in 2006, SCE's launched in 2008, and PG&E's launched in 2010.

[147] PG&E and SCE reserve funds for accepted OBF projects. SDG&E and SCG do not reserve loan funds but consider loan projects meeting program requirements committed loans.

[148] For specifics of individual IOU's accounting procedure for the loan pool account (OBF Balancing Account), please see each IOU's Preliminary Statement for OBFBA.

[149] SDG&E and SCG maintain their non-PPP ratepayer-funded loan pool in approved 2-way balancing accounts, as a result, their loan pools are not capped and are able to collect additional funding beyond the loan pool size shown here to fund committed OBF projects. Due to this the amount shown is the minimum amount available.

Table 28: Statewide Lending by Market

Statewide Lending by Market, 2013-2015	Agriculture	Commercial	Industrial	Institutional	Multi-Family	Total
Number of Loans	30	2,226	97	403	31	2,787
% of Total Number	1%	80%	3%	14%	1%	100%
Amount Loaned	$1,752,074	$57,780,880	$4,805,341	$41,728,820	$895,720	$106,962,850
% of Total Amount	2%	54%	4%	39%	1%	100%
Average Loan Size	$58,402	$25,957	$49,540	$108,545	$28,894	$38,379

More than half of measures financed through OBF were lighting equipment only while "lighting plus other type of equipment" accounted for an additional 29 percent.[150]

Highlights

Finance plays a crucial role in increasing energy savings, especially among the residential sector. One finance evaluation study found that over half of homeowners surveyed (54 percent) agreed that high upfront cost is why they might not make an energy-related upgrade and a third of homeowners stated that a loan could help overcome the costs.

The default rate across the utilities is shown in Table 32. Default rates are kept in check by strict underwriting criteria. Other factors, such as the improving housing market and positive employment conditions may also be contributing to relatively low default rate levels. Table 31 shows the total amounts and percentages of defaulted loans in the financing program through 2015.

The CPUC, in cooperation with the California Alternative Energy and Advanced Transportation Authority (CAEATFA), investor-owned utilities (IOUs), and financial institutions, developed a series of pilot programs to explore how to expand access to financing for consumers undertaking energy efficiency retrofits. The pilot programs are designed to enable consumers to undertake deeper and broader energy efficiency projects than previously achieved through traditional programs.[151] Primarily, the pilots are designed to provide credit enhancements to lenders mitigating their risk, thus supporting lower interest rates and better terms for consumers. The pilots also aimed to broaden the availability of financing to individuals who might not have been able to access it otherwise and address upfront cost barriers to energy efficiency retrofit projects.

[150] "Other types of equipment includes appliances, HVAC, boilers and steam systems, industrial systems, cross portfolio, motors, electronics and IT systems, refrigeration, food service technology, building shell, pumps and fans, and energy management systems
[151] The CPUC approved Decision 13-09-044 authorizing two-year pilot programs for serving four market segments i.e. single-family, multi-family affordable housing with master meters, small business, and On-Bill Repayment (OBR) of financing by non-residential energy users.

The first finance pilot program was Residential Energy Efficiency Loan (REEL) Assistance program that was launched in July 2016. As the first finance pilot to be implemented, REEL revealed unforeseen administrative hurdles and provided valuable lessons learned for future implementation. Despite these initial hurdles, REEL produced promising results as loan dollar volumes quickly accelerated after these start-up challenges. CAEATFA plans to launch two other finance pilots, targeting small businesses and affordable multifamily homes, in near future. Should these pilots produce promising results; the CPUC will consider their long-term implementation.

Table 29: Cumulative Loan Defaults and Partial Payments since Inception through 2015

IOU	Number of Defaults	Total Amount Defaulted	% of Defaulted Amount over Total Issued Loan Amount
PG&E	4	$49,603	0.08%
SCE	75	$607,084	1.32%
SDG&E	35	$418,014	0.86%
SCG	1	$1,271	0.05%

Findings

Findings from several market studies are compiled in the following section while findings from the two Finance impact evaluations are detailed separately in sub-sections below. A number of studies are on hold pending launch or completion of the Finance Energy Efficiency pilots.

Market and Process Evaluations:

A review of the California energy efficiency finance landscape found that there are three common types of energy efficiency financing products currently available on the market: home equity loans, term loans (i.e., term loans from financial institutions that can be either secured or unsecured against equipment), and Property Assessed Clean Energy (PACE) loans. Of these options, PACE dominates the energy efficient financing volume.[152]

A study on PACE loans for single-family homeowners found that financing is an important factor for achieving larger energy efficiency improvement projects with multiple measures.[153] However, despite contractors being aware of energy efficient financing options, only 15 percent directly promote them.[154] From the homeowners' perspective, one in three homeowners are aware of some form of energy efficient financing and only one in ten are currently aware of PACE. The Residential market study found that one-third of homeowners completed energy-related upgrades in the last two years and one quarter of those homeowners used some form of financing. Among those who used financing, 14 percent used energy efficient financing such as PACE or energy efficient loans. These findings indicate that there is still an opportunity to promote energy efficiency finance options to support large, multiple measure energy efficiency improvement projects.

[152] Market Study #1: Residential
[153] HERO Program Profile Final Report
[154] Market Study #1: Residential

Impact Evaluations:

Impact Evaluation #1 – Cross-Cutting Background and Attribution Research

A series of white papers were issued that explored ways to approach cost-effectiveness and attribution for the Financing programs. The cost-effectiveness white paper outlined an approach to cost-effectiveness that aligns with the current CA Cost-Effectiveness Framework. The paper also suggested an alternative approach to the current Framework that incorporates non-energy benefits and explains the importance of including non-energy benefits for financing efforts. The attribution white paper explores all of the concepts that must be accounted for when assessing attribution from financing programs and explains why it must be different from the current CA Net-To-Gross Framework for incentive programs. The paper weighs the benefits and drawbacks of various methods and ultimately recommends a discrete-choice approach as that method allows for an assessment of all factors at play in a financing decision.

Impact Evaluation #2 – Multiphase On-Bill Finance Study

This report presents findings from the impact evaluation of the program years 2013/14 On-Bill finance (OBF) programs. The purpose of this study was to quantify OBF program energy savings for the evaluation period (PY2013/14), to determine the impact of the OBF programs on the installation of energy-efficient equipment by non-residential customers, and to assess the relative importance of the OBF loan and the program incentive in customer decision-making. This study performed five distinct analyses, including Gross Impact, Net Impact, Incremental Net Impact, OBF Loan-to-Incentive Ratio, and Funding Source. During the 2013-2014 program cycle, four PAs issued 1,812 loans, providing over $64 million in financing. Compared to the 2010-12 program cycle, the number of loans increased three-fold and the total loan volume increased four-fold. Most of this increase came from PG&E's program, which launched during the 2010-12 program cycle, but SCE also experienced a significant increase in program activity. Both SDG&E and SCG had reduced program activity during 2013/14. The statewide program achieved 294,163 MMBtus in ex post savings, which were, on average, 79 percent of ex ante savings. The overall estimated net-to-gross ratio for 2013-2014 OBF projects is 0.67. The overall incremental net-to-gross ratio of OBF beyond incentives is 0.09 for energy savings and 0.08 for demand savings.

Path to Statewide Goals

The CPUC, in collaboration with the state's investor-owned utilities and the California Alternative Energy and Advanced Transportation Financing Authority, continues to develop the California Hub for Energy Efficiency Financing Pilot Programs. The pilot programs will encourage and leverage private lending and investment with various features such as loan loss reserves, debt service reserve funds, and on-bill repayment. These features also should allow lenders to offer better rates and terms by reducing their risk. In turn, consumers will have increased access to lower-cost financing, allowing them to upgrade their homes and businesses while saving money on energy.[155]

Addressing these up-front cost barriers is a crucial aspect of achieving the doubling of energy efficiency statewide. As the "low-hanging fruit" efficiency measures are implemented, financing for larger, more ambitious efficiency projects will become of increasing importance.

[155] California Alternative Energy and Advanced Transportation Financing Authority. Website. http://www.treasurer.ca.gov/caeatfa/cheef/background.asp

Public Utilities Code 913.9 Report

Efforts to Avoid Program Duplication with Sister Agencies in 2017

Public Utilities Code 913.9:

The CPUC shall report annually on its efforts to identify ratepayer-funded energy efficiency programs that are similar to programs administered by the Energy Commission, the State Air Resources Board, and the California Alternative Energy and Advanced Transportation Financing Authority in its annual report prepared pursuant to Section 913 and to require revisions to ratepayer-funded programs as necessary to ensure that the ratepayer-funded programs complement and do not duplicate programs of other state agencies

CPUC Energy Division staff coordinated during 2017 with staff of the CEC, the CAEATFA, the California Air Resources Board and other agencies to develop and maintain complementary energy efficiency programs and avoid duplication of efforts.

- CPUC Energy Division staff collaborated closely with the Energy CPUC staff on the SB350 doubling of energy efficiency goals target setting to ensure that quantification of savings potential for non-utility programs did not duplicate savings estimates for utility programs.
- Energy Division staff reviewed the Air Resources Board greenhouse gas emissions scoping plan and offered comments on energy efficiency to help shape that plan.
- As part of the Joint Agency Steering Committee, the CPUC Energy Division staff coordinates on an ongoing basis with staff from the CEC, the California Independent System Operator and the Air Resources Board on issues related to load forecasting with the objective of aligning work streams, methods, and objectives.
- Energy Division staff held bi-weekly meetings with CAEATFA staff, and additional bi-weekly meetings with CAEATFA staff joined by the statewide finance administrator the Southern California Gas Company, to coordinate activities and prevent duplication on energy efficiency financing pilots.
- CPUC Energy Division staff hosted three workshops on energy efficiency finance that featured CAEATFA and the investor-owned utilities, as well as evaluation contractors and marketing contractors, to review the roles and keep the activities on track.
- CPUC Energy Division staff hosted meetings with the Energy CPUC on energy efficiency workforce education & training to coordinate the roles, and included the investor-owned utilities to coordinate further.
- CPUC Energy Division staff launched coordination activities with the CEC on responsible contractor policies for third party energy efficiency solicitations that will be done in the future by utilities.

- CPUC Energy Division staff works with Air Resources Board and the CEC on disadvantaged communities issues, particularly on implementing recommendations that result from the SB 350 barriers studies.

These meetings coordinated activities among the agencies, brought out synergies, and avoided duplication. CPUC Decisions also clarified the roles, such as when the most recent finance Decision, D.17-03-026, further defined the activities to be carried out by CAEATFA and those to be done by Energy Division.

Glossary[156]

- **COST-EFFECTIVENESS -** An indicator of the relative performance or economic attractiveness of any energy efficiency investment or practice when compared to the costs of energy produced and delivered in the absence of such an investment. In the energy efficiency field, the present value of the estimated benefits produced by an energy efficiency program as compared to the estimated total program's costs, from the perspective of either society as a whole or of individual customers, to determine if the proposed investment or measure is desirable from a variety of perspectives, e.g., whether the estimated benefits exceed the estimated costs.
- **CUSTOMER -** Any person or entity responsible for payment of an electric and/or gas bill to and with an active meter serviced by a utility company (refers to IOU customers herein).
- **DATABASE FOR ENERGY-EFFICIENT RESOURCES (DEER)** – A database sponsored by the CEC and CPUC 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. The users of the data are intended to be program planners, regulatory reviewers and planners, utility and regulatory forecasters, and consultants supporting utility and regulatory research and evaluation efforts. DEER has been designated by the CPUC as its source for deemed and impact costs for program planning.
- **DEMAND (Energy Efficiency)** - Formally peak megawatt load reduction, demand in the context of energy efficiency programs is the estimated average grid-level impact for a measure between 2 p.m. and 5 p.m. during a "heat wave" defined by three consecutive weekdays for weather conditions that are expected to produce a regional grid peak event.[157]
- **DEMAND SAVINGS** - The reduction in the demand from the pre-retrofit baseline to the post-retrofit demand, once independent variables (such as weather or occupancy) have been adjusted. This term is usually applied to billing demand, to calculate cost savings or to peak demand, for equipment sizing purposes.
- **DEMAND SIDE MANAGEMENT (DSM)** - The methods used to manage energy demand including energy efficiency, load management, fuel substitution and load building.
- **DISTRIBUTED GENERATION** - A distributed generation system involves small amounts of generation located on a utility's distribution system for the purpose of meeting local (substation level) peak loads and/or displacing the need to build additional (or upgrade) local distribution lines.
- **DOWNSTREAM** – The market sector that includes customers or the end user of a product/service. Rebates or incentives that are downstream are targeted directly to customers. See also UPSTREAM.
- **EDUCATION PROGRAMS** - Programs primarily intended to educate customers about energy-efficient technologies or behaviors or provide information about programs that offer energy efficiency or load reduction information or services.

[156] California Public Utilities Commission, *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals*. April 2006

[157] CPUC, *Energy Efficiency Policy Manual*. p.27

- **EFFECTIVE USEFUL LIFE (EUL)** - An estimate of the median number of years that the measures installed under a program are still in place and operable.
- **EFFICIENCY** - The ratio of the useful energy delivered by a dynamic system (such as a machine, engine or motor) to the energy supplied to it over the same period or cycle of operation. The ratio is usually determined under specific test conditions.
- **END-USE (MEASURES/GROUPS)** - Refers to a broad or sometimes narrower category that the program is concentrating efforts upon. Examples of end-uses include refrigeration, food service, HVAC, appliances, envelope and lighting.
- **ENERGY EFFICIENCY** - Using less energy to perform the same function. Programs designed to use energy more efficiently - doing the same with less. "Energy conservation" is a term that has also been used but it has the connotation of doing without in order to save energy rather than using less energy to perform the same function and so is not used as much today. Many people use these terms interchangeably.
- **ENERGY EFFICIENCY IMPROVEMENT** - Reduced energy use for a comparable level of service, resulting from the installation of an energy efficiency measure or the adoption of an energy efficiency practice. Level of service may be expressed in such ways as the volume of a refrigerator, temperature levels, production output of a manufacturing facility, or lighting level/square foot.
- **ENERGY EFFICIENCY MEASURE** - Installation of equipment, subsystems or systems, or modification of equipment, subsystems, systems or operations on the customer side of the meter, for the purpose of reducing energy and/or demand (and, hence, energy and/or demand costs) at a comparable level of service.
- **ENERGY EFFICIENCY OF A MEASURE** - A measure of the energy used to provide a specific service or to accomplish a specific amount of work (e.g., kWh/cubic foot of a refrigerator, therms/gallon of hot water).
- **ENERGY EFFICIENCY OF EQUIPMENT** - The percentage of gross energy input that is realized as useful energy output of a piece of equipment.
- **ENERGY EFFICIENCY PRACTICE** - The use of high-efficiency products, services and practices or an energy-using appliance or piece of equipment, to reduce energy usage while maintaining a comparable level of service when installed or applied on the customer side of the meter. Energy efficiency activities typically require permanent replacement of energy-using equipment with more efficient models. Examples: refrigerator replacement, light fixture replacement, cooling equipment upgrades.
- **ENERGY MANAGEMENT SYSTEM** - A control system (often computerized) designed to regulate the energy consumption of a building by controlling the operation of energy consuming systems, such as the heating, ventilation and air conditioning (HVAC), lighting and water heating systems.
- **ENERGY SAVINGS** - The reduction in use of energy from the pre-retrofit baseline to the post-retrofit energy use, once independent variables (such as weather or occupancy) have been adjusted.
- **EVALUATION** - The performance of studies and activities aimed at determining the effects of a program; any of a wide range of assessment activities associated with understanding or documenting program performance or potential performance, assessing program or program-related markets and market operations; any of a wide range of evaluative efforts including assessing program-induced changes in energy efficiency markets, levels of demand or energy savings and program cost-effectiveness.

- **EX-ANTE SAVINGS ESTIMATE** – Administrator-forecasted savings used for program and portfolio planning purposes as filed with the CPUC, from the Latin for "beforehand."
- **EX-POST EVALUATION ESTIMATED SAVINGS** - Savings estimates reported by the independent evaluator after the energy impact evaluation and the associated M&V efforts have been completed. If only the term "ex-post savings" is used, it will be assumed that it is referring to the ex-post evaluation estimate, the most common usage, from the Latin for "from something done afterward."
- **FREE-RIDER** - A program participant who would have implemented the program measure or practice in the absence of the program.
- **GIGAWATT (GW)** - One thousand megawatts (1,000 MW), one million kilowatts (1,000,000 kW) or one billion watts (1,000,000,000 watts) of electricity. One gigawatt is enough to supply the electric demand of about one million average California homes.
- **GIGAWATT-HOUR (GWH)** - One million kilowatt-hours of electric power.
- **GROSS LOAD IMPACT** - The change in energy consumption and/or demand that results directly from program-related actions taken by participants in a DSM program, regardless of why they participated. Related to Gross Energy Impact and Gross Demand Protocols.
- **IMPACT EVALUATION** - Used to measure the program-specific induced changes in energy and/or demand usage (such kWh, kW and therms) and/or behavior attributed to energy efficiency and demand response programs.
- **INVESTOR-OWNED UTILITY (IOU)** - Private electricity and natural gas providers in which a shareholder-elected board appoints a management team of private sector employees. CPUC oversees IOUs. Pacific Gas and Electric, San Diego Gas and Electric, and Southern California Edison comprise approximately three quarters of electricity supply in California while Southern California Gas Company provides gas service to southern California.
- **LOAD** - The amount of electric power supplied to meet one or more end user's needs. The amount of electric power delivered or required at any specified point or points on a system. Load originates primarily at the power-consuming equipment of the customer. Load should not be confused with demand, which is the rate at which power is delivered to or by a system, part of a system, or a piece of equipment.
- **LUMEN** - A measure of the amount of light available from a light source equivalent to the light emitted by one candle.
- **LUMENS/WATT** - A measure of the efficacy of a light fixture; the number of lumens output/watt of power consumed
- **MARKET** - The commercial activity (manufacturing, distributing, buying and selling) associated with products and services that affect energy usage.
- **MARKET ASSESSMENT** - An analysis function that provides an assessment of how and how well a specific market or market segment is functioning with respect to the definition of well-functioning markets or with respect to other specific policy objectives. Generally includes a characterization or description of the specific market or market segments, including a description of the types and number of buyers and sellers in the market, the key actors that influence the market, the type and number of transactions that occur on an annual basis and the extent to which energy efficiency is considered an important part of these transactions by market participants. This analysis may also include an assessment of whether or not a market has been sufficiently transformed to justify a reduction or elimination of specific program interventions. Market assessment can be

blended with strategic planning analysis to produce recommended program designs or budgets. One particular kind of market assessment effort is a baseline study, or the characterization of a market before the commencement of a specific intervention in the market, for the purpose of guiding the intervention and/or assessing its effectiveness later.

- **MARKET EFFECT** - A change in the structure or functioning of a market or the behavior of participants in a market that result from one or more program efforts. Typically, these efforts are designed to increase in the adoption of energy-efficient products, services or practices and are causally related to market interventions.
- **MARKET SECTORS** - General types of markets that a program may target or in which a service offering may be placed. Market sectors include categories such as Agricultural, Commercial, Industrial, Government and Institutional. Market sectors help the CPUC assess how well its portfolio of programs is addressing the variety of markets for energy efficiency products and services in the state.
- **MARKET SEGMENTS** - A part of a market sector that can be grouped together as a result of a characteristic similar to the group. Within the residential sector are market segments such as renters, owners, multi-family and single-family. These market segments help the CPUC assess how well its portfolio of programs is addressing the variety of segments within the markets served.
- **MIDSTREAM** – Specifically the retail market segment. Midstream incentives encourage retailers to stock more high-efficiency products in order to increase sales of these products.
- **NET LOAD IMPACT** - The total change in load that is attributable to the utility DSM program. This change in load may include, implicitly or explicitly, the effects of free-drivers, free-riders, state or federal energy efficiency standards, changes in the level of energy service and natural change effects.
- **NET-TO-GROSS RATIO (NTGR)** - A factor representing the program savings net of free ridership as compared to the total program savings, inclusive of free riders. The NTGR can be thought of how much savings in a given program area or sector are directly attributable to program interventions compared to the savings that include both program-generated savings and savings that would have occurred without program intervention.
- **PLUG LOAD** – Plug loads are energy used by equipment that is usually plugged into an outlet. Plug loads can be subdivided into various categories, such as appliances, electronic plug loads (e.g. consumer electronics), miscellaneous plug loads (e.g. aquarium pumps), and hard wired plug loads (e.g. ceiling fans, security cameras).
- **PORTFOLIO** - All IOU and non-IOU energy efficiency programs funded through authorized energy efficiency funding that are implemented during a program year or cycle.
- **REALIZATION RATE** - The ratio of evaluated savings to savings reported (pre-evaluation) by the Program Administrator.
- **REBATES** - A type of incentive provided to encourage the adoption of energy-efficient practices, typically paid after the measure has been installed. There are typically two types of rebates: a Prescriptive Rebate, which is a prescribed financial incentive/unit for a prescribed list of products, and a Customized Rebate, in which the financial incentive is determined using an analysis of the customer's equipment and an agreement on the specific products to be installed. Upstream rebates are financial incentives provided for manufacturing, sales, stocking or other per unit energy-efficient product movement activities designed to increase use of particular type of products.

- **UPSTREAM** – Refers to the market sector of manufacturers or retailers of high efficiency products. Programs can target rebates or incentives at this market sector. See also DOWNSTREAM.

Appendices

Appendix A: IOU Savings Compared to CPUC Savings Goals

An Excel file containing the data used in this appendix is available.

This appendix compares the energy savings reported by California's seven energy efficiency program administrators and the evaluated energy savings achievements for the 2013-2015 program cycle with the energy savings goals adopted by the Commission in Decision (D.)12-05-015 and D.14-10-046.

The data should not be compared against other appendix tables showing portfolio savings because only fuel types that are applicable to goal attainment are included in this appendix. For example, SCE's natural gas savings are not included, nor likewise SoCalGas's electric savings, because as single-fuel utilities the savings from the fuel type they do not supply are not established in their goals.

The following terms describe different metrics used by the CPUC in establishing goals and defining savings impacts:

- **Goals** - Energy savings targets established by the CPUC for each investor-owned utility's energy efficiency portfolio. The 2013-14 goals were based on the 2011 Energy Efficiency Potential Study conducted by the California Energy Commission; 2015 goals were based on 2013 Phase 2 updates to that study.158 For the 2013-2015 program cycle, goals are set for gross savings for GWh, MW, and Therms.
- **Reported Savings** - Also referred to as "claims," these are energy savings reported to the CPUC by the program administrators. The reported savings are based on the number of installed technologies and pre-evaluation (ex-ante) savings assumptions.
- **Evaluated Savings** - Energy savings estimates that represent adjustments to the program administrator's reported savings based on field research of the installations, performance, and market conditions gathered during evaluation activities. Evaluation studies determine updates to various savings parameters, which adjust the amount of savings that occurred and can be attributed to programs. Parameters include Unit Energy Savings (UES), Net-to-Gross Ratios (NTG), Expected and Remaining Useful Life (EUL/RUL) for dual baseline measures, Installation Rate (IR), Realization Rate (RR) In-service rate, and Gross Impacts - Energy savings that result from efficiency measures installed or actions taken by program administrator customers, regardless of whether or to what extent the programs influenced their actions.
- **Net Impacts** - Energy savings directly attributable to the program. Net savings are calculated by subtracting savings by program participants that are estimated to have happened without the program (so called "free ridership") from the gross savings estimate.

When the CPUC adopted updated savings goals for the 2013-2014 program cycle, several changes were made to previous cycles' methodology including updates to the avoided costs methodology and the DEER.

[158] http://www.cpuc.ca.gov/General.aspx?id=2013

For the 2013-2015 program cycle, the CPUC allowed the IOUs to credit savings from Low Income Energy Efficiency programs and Codes and Standards advocacy toward their goals, although these savings were not included in the savings potential study used to define the goals. In Decision 12-05-015, the CPUC decided that codes and standards goals should be separated from the program goals. This is a distinct change from the 2010-2012 program cycle in which IOUs could credit codes and standards advocacy savings toward their energy efficiency goals.

Electric and peak demand savings attained by SoCalGas, and natural gas savings attained by SCE, are not included for goal attainment.

Savings achievements from Regional Energy Networks and Community Choice Aggregators are included in their respective IOU goal attainment since goals are established for IOU territories and not individual entities (RENs and CCAs do not themselves have mandated goals).

It is important to acknowledge several challenges associated with a comparison of goals and evaluated savings. Each savings estimate is based on slightly different assumptions and available information in different time periods. The primary difference is that evaluated savings reflect newly attained information on energy efficiency market penetration, end user adoption rates, and per unit savings developed through on-site evaluations and other research. This information was not available when goals or ex ante savings estimates were established. This discrepancy in available information leads to differences between savings estimates originally used to develop the efficiency goals and the savings estimates underlying the evaluated savings results.

The following tables present the range of savings estimates, including the final evaluated savings, compared to the 2013-2015 energy efficiency savings goals. For the 2013-2015 goal attainment calculations, CPUC policy dictated Rows that program administrators were allowed to add net show combined programs/codes and standards goals and savings are for reference only and reported gross savings from low income programs towards do not reflect the official CPUC guidance on goal attainment calculation.

Table A-1: Statewide Energy Savings for 2013-2015 Portfolio: Goals, Reported, Evaluated

		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Goals	A. Gross Programs	4,410	830	130
	B. Net Codes and Standards	1,756	243	7
	C. Combined (A + B)	6,166	1,073	137
Program Savings	D. Reported Gross	5,430	1,007	132
	E. Reported Net	3,877	719	89
	F. Evaluated Gross	5,070	954	100
	G. Evaluated Net	3,230	624	67
Low Income Programs	H. Reported Gross	226	54	15
Codes and Standards	J. Reported Gross	7,362	1,441	26
	K. Reported Net	2,892	538	19
	L. Evaluated Gross	7,362	1,441	26
	M. Evaluated Net	3,923	576	13
Evaluated Gross Programs Savings including Low Incom	N. Gross Programs (F + H)	5,296	1,008	114
Evaluated Net Codes and Standards Savings	P. Net Codes and Standards (M)	3,923	576	13
Combined	Q. Combined (N+P)	9,219	1,584	127
Goals Attainment Percent	R. Gross Programs (N over A)	120%	121%	88%
	S. Net Codes and Standards (M over B)	223%	237%	183%
	T. Combined (Q over C)	150%	148%	93%

Table A-2: PG&E Energy Savings for 2013-2015 Portfolio

		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Goals	A. Gross Programs	1,889	324	56
	B. Net Codes and Standards	776	107	2
	C. Combined (A + B)	2,665	431	57
Program Savings	D. Reported Gross	2,332	452	73
	E. Reported Net	1,747	335	54
	F. Evaluated Gross	2,199	433	56
	G. Evaluated Net	1,457	292	38
Low Income Programs	H. Reported Gross	118	23	6
Codes and Standards	J. Reported Gross	3,249	636	(4)
	K. Reported Net	1,276	238	2
	L. Evaluated Gross	3,249	636	(4)
	M. Evaluated Net	1,717	249	3
Evaluated Gross Programs Savings including Low Incom	N. Gross Programs (F + H)	2,317	456	62
Evaluated Net Codes and Standards Savings	P. Net Codes and Standards (M)	1,717	249	3
Combined	Q. Combined (N+P)	4,034	705	65
Goals Attainment Percent	R. Gross Programs (N over A)	123%	141%	111%
	S. Net Codes and Standards (M over B)	221%	233%	185%
	T. Combined (Q over C)	151%	163%	113%

Table A-3: SCE Energy Savings for 2013-2015 Portfolio

		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Goals	A. Gross Programs	2,030	408	-
	B. Net Codes and Standards	800	111	-
	C. Combined (A + B)	2,829	518	-
Program Savings	D. Reported Gross	2,604	462	-
	E. Reported Net	1,795	320	-
	F. Evaluated Gross	2,383	428	-
	G. Evaluated Net	1,481	274	-
Low Income Programs	H. Reported Gross	91	29	-
Codes and Standards	J. Reported Gross	3,352	656	-
	K. Reported Net	1,317	245	-
	L. Evaluated Gross	3,352	656	-
	M. Evaluated Net	1,804	268	-
Evaluated Gross Programs Savings including Low Incom	N. Gross Programs (F + H)	2,474	458	-
Evaluated Net Codes and Standards Savings	P. Net Codes and Standards (M)	1,804	268	-
Combined	Q. Combined (N+P)	4,278	726	-
Goals Attainment Percent	R. Gross Programs (N over A)	122%	112%	
	S. Net Codes and Standards (M over B)	226%	243%	
	T. Combined (Q over C)	151%	140%	

Table A-4: SCG Energy Savings for 2013-2015 Portfolio

		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Goals	A. Gross Programs	-	-	68
	B. Net Codes and Standards	-	-	5
	C. Combined (A + B)	-	-	73
Program Savings	D. Reported Gross	-	-	56
	E. Reported Net	-	-	33
	F. Evaluated Gross	-	-	42
	G. Evaluated Net	-	-	27
Low Income Programs	H. Reported Gross	-	-	8
Codes and Standards	J. Reported Gross	-	-	30
	K. Reported Net	-	-	17
	L. Evaluated Gross	-	-	30
	M. Evaluated Net	-	-	9
Evaluated Gross Programs Savings including Low Incom	N. Gross Programs (F + H)	-	-	49
Evaluated Net Codes and Standards Savings	P. Net Codes and Standards (M)	-	-	9
Combined	Q. Combined (N+P)	-	-	58
Goals Attainment Percent	R. Gross Programs (N over A)			73%
	S. Net Codes and Standards (M over B)			182%
	T. Combined (Q over C)			80%

Table A-5: SDG&E Energy Savings for 2013-2015 Portfolio

		Electric (GWh)	Demand (MW)	Natural Gas (MM Therms)
Goals	A. Gross Programs	492	98	6.6
	B. Net Codes and Standards	181	25	0.2
	C. Combined (A + B)	673	124	6.8
Program Savings	D. Reported Gross	494	92	3.6
	E. Reported Net	334	64	2.3
	F. Evaluated Gross	488	93	2.3
	G. Evaluated Net	292	59	2.0
Low Income Programs	H. Reported Gross	17	2	0.9
Codes and Standards	J. Reported Gross	761	149	(0.5)
	K. Reported Net	299	56	0.2
	L. Evaluated Gross	761	149	(0.5)
	M. Evaluated Net	402	58	0.4
Evaluated Gross Programs Savings including Low Incom	N. Gross Programs (F + H)	505	95	3.2
Evaluated Net Codes and Standards Savings	P. Net Codes and Standards (M)	402	58	0.4
Combined	Q. Combined (N+P)	907	153	3.6
Goals Attainment Percent	R. Gross Programs (N over A)	103%	96%	49%
	S. Net Codes and Standards (M over B)	222%	231%	188%
	T. Combined (Q over C)	135%	124%	53%

Appendix B: Energy Savings by Sector and End Use

An Excel file containing the data used in this appendix is available.

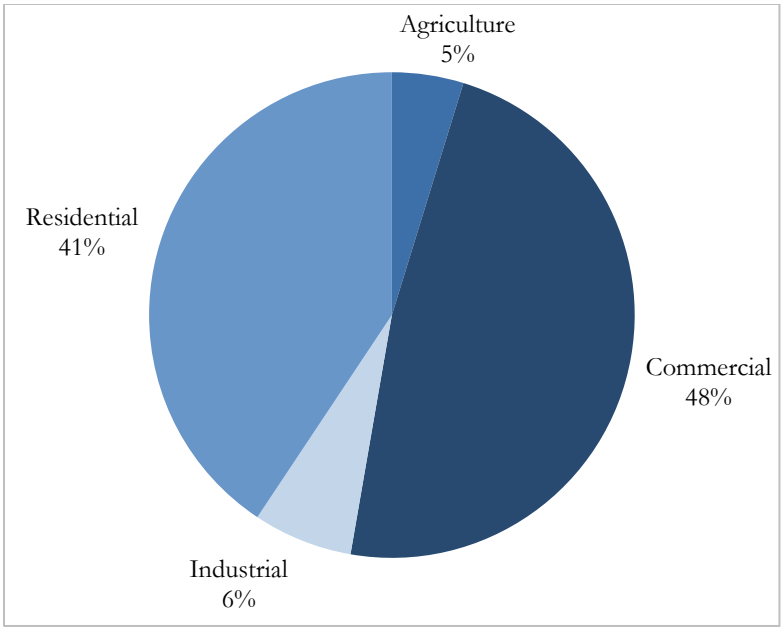
This appendix shows both first-year and lifecycle savings for each market sector and end use. The majority of first-year energy savings are concentrated in the residential and commercial market sectors. Key end uses include HVAC and indoor lighting for electric savings and large industrial processes for natural gas savings.

The evaluations conducted in the 2013-2015 period considered all fuel impacts of the installed measures, including interactive effects. For instance, the evaluations estimate the positive electric savings from reduced air conditioning load and negative natural gas savings from increased heating load that result from installation of more efficient interior lighting and refrigeration measures. Consequently, electric impacts are reflected for SCG and natural gas impacts are shown for SCE, despite both of these IOUs being single-fuel utilities. These impacts are not considered compared to goals, since neither utility has goals for energy types it does not sell.

Savings from codes and standards are not included in this appendix. All net savings values include a 5 percent market effects adjustment, as determined in D.12.11.015.[159]

The savings estimates provided in this appendix reflect savings parameter updates that were updated based on the evaluation studies.[160] Appendix H provides a decision tree that illustrates how findings from evaluation studies were used to update each parameter in the program tracking data. First year savings are calculated for electricity, demand, and natural gas savings, while lifecycle savings are calculated for electricity and gas savings only.

Figure B-1a: Distribution of First Year Evaluated Net Electricity Savings by Sector



[159] D.12.11.015, Ordering Paragraph 37.
[160] Savings parameter updates included Unit Energy Savings, Effective Useful Life, installation rates, realization rates, measure Costs and Net to Gross ratios.

FigureB-2a: Distribution of First Year Evaluated Net Natural Gas Savings by Sector

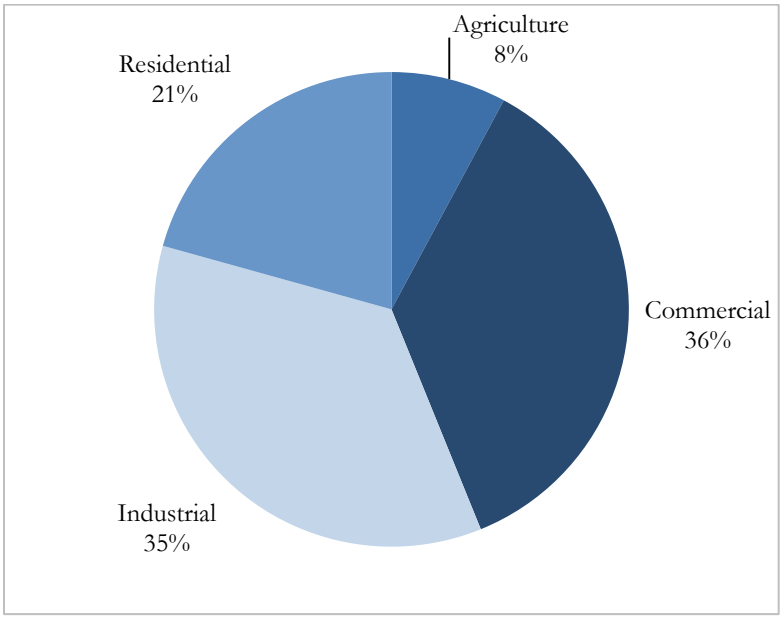


Figure B-1b: Distribution of Lifecycle Evaluated Net Electricity Savings by Sector

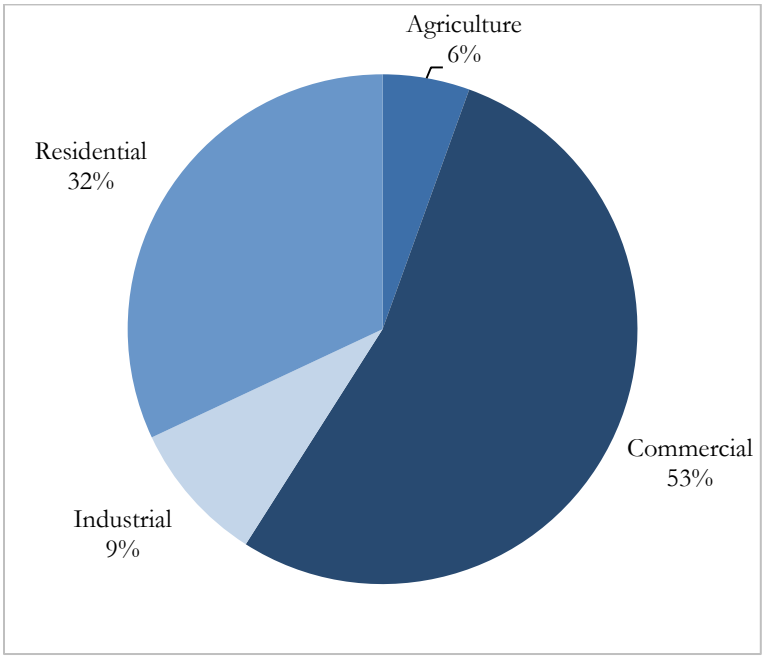


Figure B-2b: Distribution of Lifecycle Evaluated Net Natural Gas Savings by Sector

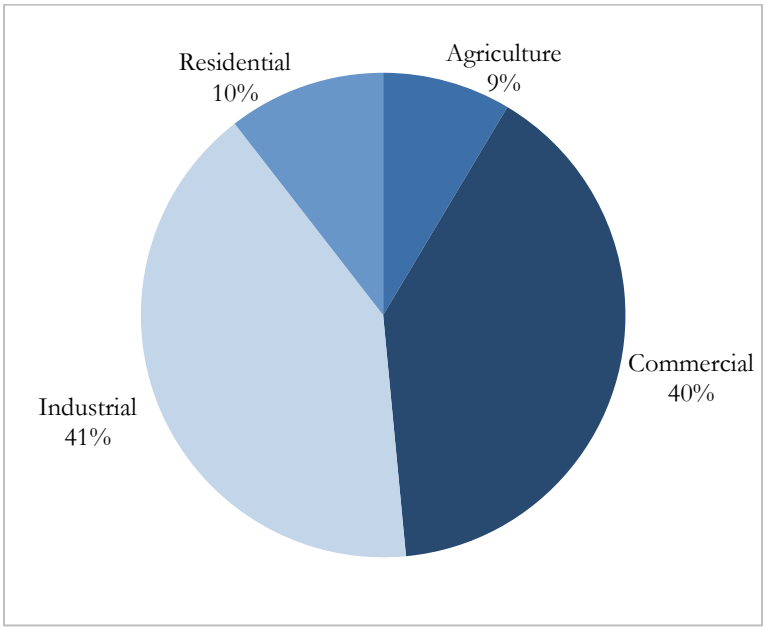


Table B-1a: 2013-2015 Statewide First Year Energy Savings by Sector

Peak Demand Savings (kW)				
Target Sector	Reported Gross	Evaluated Gross	Reported Net	Evaluated Net
Agriculture	84,472	62,104	57,258	36,355
Commercial	482,269	457,067	345,170	292,332
Industrial	75,621	52,151	53,081	31,092
Residential	377,149	395,437	272,552	272,635
Total	**1,019,511**	**966,759**	**728,061**	**632,414**
Electric Savings (kWh)				
Target Sector	Reported Gross	Evaluated Gross	Reported Net	Evaluated Net
Agriculture	335,134,037	256,812,240	232,768,525	154,648,213
Commercial	2,709,089,360	2,458,649,067	1,963,775,857	1,557,542,935
Industrial	545,152,320	366,475,195	381,564,953	214,947,839
Residential	1,868,687,344	2,015,916,566	1,316,382,105	1,320,094,524
Total	**5,458,063,060**	**5,097,853,068**	**3,894,491,440**	**3,247,233,510**
Natural Gas Savings (Therms)				
Target Sector	Reported Gross	Evaluated Gross	Reported Net	Evaluated Net
Agriculture	10,840,604	8,074,871	7,285,051	4,633,115
Commercial	48,031,568	36,126,682	30,950,355	21,261,920
Industrial	51,564,295	33,419,144	32,067,415	20,936,142
Residential	10,637,553	8,708,186	11,343,915	12,213,254
Total	**121,074,019**	**86,328,882**	**81,646,736**	**59,044,431**

Table B-1b: 2013-2015 Statewide Lifecycle Energy Savings by Sector

Target Sector	Reported Gross	Evaluated Gross	Reported Net	Evaluated Net
Agriculture	3,763,493,232	2,734,790,769	2,623,129,614	1,648,502,780
Commercial	28,183,439,760	24,600,270,046	20,704,009,534	15,964,086,187
Industrial	7,156,600,799	4,592,065,751	4,950,281,236	2,687,337,694
Residential	15,285,834,399	16,918,022,352	10,018,692,615	9,542,728,407
Total	**54,389,368,190**	**48,845,148,917**	**38,296,113,000**	**29,842,655,067**
Natural Gas Savings (Therms)				
Target Sector	Reported Gross	Evaluated Gross	Reported Net	Evaluated Net
Agriculture	141,804,754	100,598,222	97,912,374	58,317,781
Commercial	583,384,647	439,074,333	381,915,988	271,609,155
Industrial	696,017,174	442,945,100	435,211,101	278,925,063
Residential	115,590,961	63,271,935	85,659,009	71,474,109
Total	**1,536,797,536**	**1,045,889,590**	**1,000,698,472**	**680,326,109**

Table B-2a: 2013-2015 First Year Savings by Sector and Program Administrator

		Reported kW		Evaluated kW		Reported kWh		Evaluted kWh		Reported Therms		Evaluated Therms	
Sector	IOU	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Agriculture	PGE	65,893	43,800	47,224	26,310	247,305,661	168,787,016	182,483,966	104,977,756	9,762,193	6,624,311	6,997,724	3,974,144
	SCE	18,539	13,433	14,858	10,030	87,298,041	63,646,350	73,862,277	49,372,104	(8,019)	(4,480)	(9,468)	(6,353)
	SCG	-	-	-	-	264,687	161,376	264,687	161,376	771,922	467,663	771,922	467,663
	SDGE	39	26	22	15	265,648	173,782	201,310	136,977	314,508	197,557	314,693	197,662
	BAY	-	-	-	-	-	-	-	-	-	-	-	-
	MCE	-	-	-	-	-	-	-	-	-	-	-	-
	SCR	-	-	-	-	-	-	-	-	-	-	-	-
	Total	84,472	57,258	62,104	36,355	335,134,037	232,768,525	256,812,240	154,648,213	10,840,604	7,285,051	8,074,871	4,633,115
Commercial	PGE	186,904	132,560	183,247	111,476	1,120,474,113	818,911,894	1,029,740,161	640,494,247	27,632,335	18,607,777	21,467,443	11,867,662
	SCE	239,964	173,436	217,988	145,486	1,291,511,906	936,459,274	1,152,591,252	744,122,579	(689,602)	(562,445)	(804,906)	(590,543)
	SCG	1	1	1	1	(87,479)	(57,963)	(87,479)	(57,963)	17,546,804	10,637,996	13,322,614	8,695,546
	SDGE	55,090	38,949	55,520	35,144	295,184,203	207,054,229	274,398,516	171,555,019	3,532,345	2,256,938	2,131,844	1,279,247
	BAY	-	-	-	-	-	-	-	-	-	-	-	-
	MCE	311	224	311	226	2,006,617	1,408,424	2,006,617	1,429,053	9,687	10,088	9,687	10,007
	SCR	-	-	-	-	-	-	-	-	-	-	-	-
	Total	482,269	345,170	457,067	292,332	2,709,089,360	1,963,775,857	2,458,649,067	1,557,542,935	48,031,568	30,950,355	36,126,682	21,261,920
Industrial	PGE	29,064	20,365	21,872	12,884	196,503,339	138,355,073	142,791,256	84,879,690	26,287,964	18,009,672	18,131,462	10,591,002
	SCE	43,762	30,798	27,972	16,697	326,048,483	227,665,475	208,355,561	120,620,425	(4,687)	(4,989)	(14,501)	(10,408)
	SCG	-	-	-	-	-	-	-	-	24,524,854	13,578,822	14,811,634	10,080,636
	SDGE	2,769	1,901	2,281	1,494	22,516,729	15,489,955	15,244,609	9,393,274	756,637	484,218	491,021	275,220
	BAY	-	-	-	-	-	-	-	-	-	-	-	-
	MCE	26	17	26	17	83,770	54,450	83,770	54,450	(473)	(307)	(473)	(307)
	SCR	-	-	-	-	-	-	-	-	-	-	-	-
	Total	75,621	53,081	52,151	31,092	545,152,320	381,564,953	366,475,195	214,947,839	51,564,295	32,067,415	33,419,144	20,936,142
Residential	PGE	168,246	136,724	179,282	140,324	758,457,845	612,491,407	835,551,313	620,857,394	8,758,225	9,901,462	8,424,491	11,143,301
	SCE	158,776	101,343	166,881	101,167	896,737,721	565,620,567	946,558,865	565,526,174	(10,592,723)	(6,620,439)	(12,361,045)	(7,439,579)
	SCG	13,005	8,567	12,627	8,226	28,290,936	17,841,101	27,606,609	17,223,720	12,669,612	7,995,683	12,528,909	7,713,843
	SDGE	34,099	23,198	35,154	21,917	175,567,913	111,764,798	197,921,265	111,030,350	(971,343)	(627,522)	(629,757)	239,223
	BAY	1,835	1,652	692	461	7,282,648	6,554,384	6,195,495	4,000,200	644,167	579,751	624,607	465,374
	MCE	33	30	33	30	378,124	334,908	378,124	334,908	34,664	29,526	34,664	29,526
	SCR	1,154	1,038	767	510	1,972,156	1,774,940	1,704,894	1,121,778	94,950	85,455	86,318	61,566
	Total	377,149	272,552	395,437	272,635	1,868,687,344	1,316,382,105	2,015,916,566	1,320,094,524	10,637,553	11,343,915	8,708,186	12,213,254
Total		**1,019,511**	**728,061**	**966,759**	**632,414**	**5,458,063,060**	**3,894,491,440**	**5,097,853,068**	**3,247,233,510**	**121,074,019**	**81,646,736**	**86,328,882**	**59,044,431**

Table B-2b: 2013-2015 Lifecycle Savings by Sector and Program Administrator

		Reported kWh		Evaluted kWh		Reported Therms		Evaluated Therms	
Sector	IOU	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Agriculture	PGE	2,962,690,298	2,044,719,907	2,124,123,625	1,250,061,242	136,251,889	94,505,588	95,046,028	54,914,616
	SCE	797,804,389	576,508,448	607,752,791	396,545,990	(56,610)	(34,572)	(57,519)	(38,206)
	SCG	1,323,436	806,881	1,323,436	806,881	3,859,610	2,338,314	3,859,610	2,338,314
	SDGE	1,675,110	1,094,377	1,590,917	1,088,667	1,749,864	1,103,044	1,750,103	1,103,058
	BAY	-	-	-	-	-	-	-	-
	MCE	-	-	-	-	-	-	-	-
	SCR	-	-	-	-	-	-	-	-
	Total	3,763,493,232	2,623,129,614	2,734,790,769	1,648,502,780	141,804,754	97,912,374	100,598,222	58,317,781
Commercial	PGE	12,537,916,643	9,302,464,838	10,795,580,025	6,913,467,397	306,712,734	215,553,839	237,970,136	142,138,682
	SCE	12,695,610,010	9,342,819,159	10,949,624,209	7,224,816,416	(1,742,647)	(2,701,436)	(3,950,137)	(3,779,023)
	SCG	(1,835,647)	(1,215,201)	(1,835,647)	(1,215,201)	238,428,782	143,810,542	178,975,631	117,704,999
	SDGE	2,932,634,949	2,046,157,859	2,837,787,655	1,813,005,707	39,876,974	25,138,910	25,969,898	15,431,284
	BAY	-	-	-	-	-	-	-	-
	MCE	19,113,805	13,782,879	19,113,805	14,011,868	108,806	114,133	108,806	113,213
	SCR	-	-	-	-	-	-	-	-
	Total	28,183,439,760	20,704,009,534	24,600,270,046	15,964,086,187	583,384,647	381,915,988	439,074,333	271,609,155
Industrial	PGE	2,644,889,740	1,856,310,824	1,835,287,406	1,094,568,901	358,045,121	247,650,657	240,279,799	141,389,009
	SCE	4,215,235,411	2,891,768,526	2,554,742,358	1,467,858,984	28,756	(15,216)	(139,191)	(105,096)
	SCG	-	-	-	-	329,938,477	182,421,726	197,801,161	134,836,160
	SDGE	296,050,229	201,925,363	201,610,568	124,633,286	8,007,224	5,155,496	5,005,735	2,806,553
	BAY	-	-	-	-	-	-	-	-
	MCE	425,419	276,522	425,419	276,522	(2,405)	(1,563)	(2,405)	(1,563)
	SCR	-	-	-	-	-	-	-	-
	Total	7,156,600,799	4,950,281,236	4,592,065,751	2,687,337,694	696,017,174	435,211,101	442,945,100	278,925,063
Residential	PGE	4,685,493,140	3,279,457,338	5,303,673,940	2,962,528,579	47,317,973	40,095,312	25,324,551	38,730,666
	SCE	8,266,131,235	5,179,323,051	9,179,291,816	5,274,402,391	(99,036,761)	(62,899,621)	(121,568,283)	(70,699,356)
	SCG	381,929,029	246,763,819	370,637,543	236,571,765	160,554,366	101,305,519	158,015,951	97,061,840
	SDGE	1,785,694,198	1,163,291,262	1,942,412,795	988,477,988	(5,386,288)	(3,751,598)	(9,766,165)	(2,087,090)
	BAY	124,263,458	111,837,112	97,217,003	64,525,320	11,292,927	10,163,634	10,141,908	7,707,695
	MCE	4,219,473	3,726,554	4,219,473	3,726,554	411,139	351,919	411,139	351,919
	SCR	38,103,866	34,293,479	20,569,782	12,495,809	437,605	393,844	712,834	408,436
	Total	15,285,834,399	10,018,692,615	16,918,022,352	9,542,728,407	115,590,961	85,659,009	63,271,935	71,474,109
Total		54,389,368,189.60	38,296,113,000	48,845,148,917	29,842,655,067	1,536,797,536	1,000,698,472	1,045,889,590	680,326,109

Table B-3a: 2013-2015 Statewide First Year Energy Savings by End Use

Peak Demand (kW)	**Gross**		**Net**	
End Use	Reported	Evaluted	Reported	Evaluted
Appliance	54,377	54,351	33,618	33,602
Food Service	1,537	1,466	1,047	997
HVAC	199,860	178,404	151,230	129,983
Indoor Lighting	393,777	412,395	275,126	250,939
Other	30,149	36,443	26,261	32,805
Outdoor Lighting	2,139	2,107	1,426	1,257
Plug Loads	2,869	2,495	1,691	1,428
Process	123,465	81,396	84,677	47,616
Refrigeration	39,033	34,292	27,551	23,374
Water Heating	804	794	511	500
Whole Building	171,500	162,615	124,923	109,912
Total	1,019,511	966,759	728,061	632,414
Electric (kWh)	**Gross**		**Net**	
End Use	Reported	Evaluted	Reported	Evaluted
Appliance	250,814,605	250,694,063	154,565,671	154,486,117
Food Service	7,445,165	7,108,961	5,065,527	4,821,799
HVAC	840,917,243	627,354,449	627,409,865	422,821,577
Indoor Lighting	2,374,583,195	2,507,519,988	1,630,794,534	1,485,471,017
Other	171,759,732	181,013,611	146,480,709	159,000,061
Outdoor Lighting	296,585,901	275,659,262	223,583,501	165,295,901
Plug Loads	48,920,205	44,871,052	23,287,050	20,580,322
Process	704,493,094	458,964,834	485,843,818	271,145,165
Refrigeration	276,227,424	241,885,118	193,431,769	162,723,245
Water Heating	4,998,120	4,916,114	3,288,497	3,182,187
Whole Building	481,318,376	497,865,615	400,740,499	397,706,120
Total	5,458,063,060	5,097,853,068	3,894,491,440	3,247,233,510
Natural Gas (Therms	**Gross**		**Net**	
End Use	Reported	Evaluted	Reported	Evaluted
Appliance	1,410,147	1,305,865	638,978	592,789
Food Service	6,658,694	6,525,075	4,326,457	4,265,554
HVAC	21,373,998	14,470,575	15,324,470	9,084,015
Indoor Lighting	(22,682,591)	(25,641,848)	(14,766,306)	(14,332,234)
Other	10,836,798	8,232,618	7,688,732	6,606,384
Outdoor Lighting	22,221	10,844	14,075	5,653
Plug Loads	34,957	(201,322)	187,277	76,391
Process	64,244,971	44,092,708	41,005,513	27,216,447
Refrigeration	2,193,473	1,828,672	1,328,851	1,187,510
Water Heating	15,059,015	14,718,773	9,670,939	9,279,463
Whole Building	21,922,337	20,986,921	16,227,749	15,062,460
Total	121,074,019	86,328,882	81,646,736	59,044,431

Table B-3b: 2013-2015 Statewide Lifecycle Savings by End Use

Electric (kWh)	Gross		Net	
End Use	Reported	Evaluted	Reported	Evaluted
Appliance	1,878,848,727	1,877,065,868	1,157,526,534	1,156,304,128
Food Service	89,405,998	84,354,393	60,819,174	57,266,375
HVAC	10,519,948,590	7,664,419,411	7,698,175,130	5,173,484,390
Indoor Lighting	21,634,887,025	23,789,585,730	15,054,645,688	13,933,477,371
Other	931,983,198	836,670,582	621,768,330	559,050,704
Outdoor Lighting	3,369,262,418	2,924,752,332	2,519,335,729	1,752,259,456
Plug Loads	273,473,197	255,378,964	117,548,299	105,623,215
Process	8,545,006,977	5,416,846,252	5,827,376,024	3,189,989,585
Refrigeration	3,661,167,196	3,087,560,013	2,582,327,890	2,091,401,004
Water Heating	54,234,993	52,983,079	35,303,007	33,939,712
Whole Building	3,431,149,871	2,855,532,294	2,621,287,195	1,789,859,128
Total	54,389,368,190	48,845,148,917	38,296,113,000	29,842,655,067
Natural Gas (Therms	**Gross**		**Net**	
End Use	Reported	Evaluted	Reported	Evaluted
Appliance	30,038,066	28,674,718	15,865,733	15,240,486
Food Service	79,944,755	78,257,220	51,939,271	51,160,537
HVAC	263,384,417	185,814,272	178,109,713	115,723,605
Indoor Lighting	(222,151,457)	(264,123,144)	(145,193,659)	(142,433,840)
Other	87,388,398	54,241,295	51,711,635	36,637,911
Outdoor Lighting	306,030	128,010	212,789	66,987
Plug Loads	322,735	(1,409,015)	1,364,175	539,560
Process	872,840,702	582,044,945	558,434,171	359,865,443
Refrigeration	19,218,370	15,316,247	11,436,591	9,846,681
Water Heating	210,354,348	204,998,361	135,499,692	129,757,755
Whole Building	195,151,171	161,946,682	141,318,361	103,920,983
Total Therms	1,536,797,536	1,045,889,590	1,000,698,472	680,326,109

Table B-4a: 2013-2015 Statewide First Year Savings by Sector and End use

		Demand (kW)				Electric (kWh)				Natural Gas (MMTherms)			
		Gross		Net		Gross		Net		Gross		Net	
Sector	End Use	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated
Agriculture	Appliance	8	8	5	5	77,806	77,806	52,145	52,145	1,498	1,498	1,076	1,076
	Food Service	10	10	6	6	44,318	44,318	28,807	28,807	28,975	28,975	18,834	18,834
	HVAC	6,485	5,967	4,286	3,869	19,999,024	16,823,813	14,197,534	10,677,663	708,714	481,732	544,934	276,157
	Indoor Lighting	5,150	4,629	3,705	2,715	29,932,350	30,170,852	21,428,527	17,564,287	(16,773)	(17,899)	(10,441)	(11,847)
	Other	1,387	752	907	429	4,006,884	2,528,020	2,610,217	1,432,261	-	-	-	-
	Outdoor Lighting	824	723	485	412	13,814,262	14,726,910	8,953,951	8,171,189	-	-	-	-
	Plug Loads	0	0	0	0	768	768	499	499	(4)	(4)	(2)	(2)
	Process	64,853	45,608	44,077	26,779	230,619,160	165,549,504	159,443,790	101,733,032	9,842,199	7,305,878	6,670,105	4,289,460
	Refrigeration	3,790	2,584	2,774	1,493	30,548,325	21,875,614	21,982,751	12,741,297	4,189	2,886	2,723	1,616
	Water Heating	-	-	-	-	-	-	-	-	7,898	7,898	5,133	5,133
	Whole Building	1,965	1,823	1,013	645	6,091,140	5,014,634	4,070,305	2,247,033	263,907	263,907	52,689	52,689
	Total	84,472	62,104	57,258	36,355	335,134,037	256,812,240	232,768,525	154,648,213	10,840,604	8,074,871	7,285,051	4,633,115
Commercial	Appliance	1,598	1,572	1,038	1,012	15,863,367	15,742,825	10,801,949	10,704,669	254,730	152,723	147,306	100,018
	Food Service	1,521	1,451	1,037	986	7,358,565	7,022,361	5,006,827	4,763,100	6,582,105	6,459,542	4,279,659	4,223,026
	HVAC	117,122	100,418	89,583	72,857	658,125,345	484,494,268	493,691,586	325,398,743	16,121,623	10,551,347	11,961,065	6,642,687
	Indoor Lighting	249,547	259,657	179,637	165,448	1,234,638,861	1,279,194,410	889,086,396	808,325,887	(3,771,537)	(4,148,553)	(2,686,125)	(2,661,913)
	Other	1,660	1,178	1,084	716	17,588,723	11,986,479	11,481,196	7,362,128	4,399,334	2,938,731	2,736,726	1,920,454
	Outdoor Lighting	1,093	1,060	792	618	247,087,233	227,095,644	186,479,196	135,241,558	22,886	11,509	14,647	6,225
	Plug Loads	2,418	2,046	1,584	1,322	30,841,778	26,798,379	20,361,857	17,657,899	(33,268)	(30,990)	(22,814)	(21,342)
	Process	15,195	9,083	10,698	5,207	126,523,675	77,727,736	89,022,897	44,232,416	10,429,907	7,869,472	6,546,303	4,779,042
	Refrigeration	31,475	29,210	22,059	20,278	217,834,007	202,128,212	152,078,114	139,041,678	1,817,855	1,624,549	1,121,153	1,053,371
	Water Heating	203	192	121	114	875,940	793,935	525,381	466,600	4,839,233	4,560,842	3,203,502	3,051,913
	Whole Building	60,438	51,202	37,536	23,774	152,351,865	125,664,818	105,240,458	64,348,256	7,368,701	6,137,509	3,648,932	2,168,438
	Total	482,269	457,067	345,170	292,332	2,709,089,360	2,458,649,067	1,963,775,857	1,557,542,935	48,031,568	36,126,682	30,950,355	21,261,920
Industrial	Appliance	15	15	10	10	163,575	163,575	107,314	107,314	6,217	3,942	3,612	2,687
	Food Service	19	19	12	12	90,468	90,468	58,804	58,804	38,517	27,461	22,506	18,237
	HVAC	12,078	7,949	8,723	5,026	85,251,941	51,918,835	61,124,855	31,011,987	2,822,612	1,712,155	1,749,464	1,116,808
	Indoor Lighting	14,089	13,169	10,759	8,391	67,877,552	65,069,124	51,827,857	40,195,629	(97,166)	(98,129)	(72,973)	(67,548)
	Other	355	184	233	98	1,638,741	1,043,000	1,080,128	557,865	3,479,938	1,977,295	1,915,909	1,275,887
	Outdoor Lighting	218	214	144	129	13,682,386	12,677,223	10,615,337	7,129,449	-	-	-	-
	Plug Loads	6	6	4	4	19,008	19,008	12,355	12,355	507,774	269,079	279,267	166,826
	Process	43,018	26,466	29,666	15,477	344,109,497	213,653,944	235,488,863	123,902,079	43,972,178	28,916,670	27,788,569	18,147,409
	Refrigeration	3,073	1,804	2,148	1,034	25,128,159	15,164,962	17,181,318	8,751,524	375,251	205,061	208,405	135,953
	Water Heating	-	-	-	-	-	-	-	-	106,848	87,541	64,783	56,080
	Whole Building	2,750	2,324	1,382	911	7,190,992	6,675,056	4,068,123	3,220,833	352,125	318,069	107,872	83,803
	Total	75,621	52,151	53,081	31,092	545,152,320	366,475,195	381,564,953	214,947,839	51,564,295	33,419,144	32,067,415	20,936,142
Residential	Appliance	52,757	52,757	32,566	32,575	234,709,858	234,709,858	143,604,264	143,621,989	1,147,702	1,147,702	486,984	489,007
	Food Service	(13)	(13)	(8)	(8)	(48,186)	(48,186)	(28,912)	(28,912)	9,097	9,097	5,458	5,458
	HVAC	64,175	64,070	48,638	48,231	77,540,932	74,117,534	58,395,891	55,733,183	1,721,049	1,725,341	1,069,007	1,048,364
	Indoor Lighting	124,991	134,940	81,025	74,385	1,042,134,431	1,133,085,601	668,451,754	619,385,214	(18,797,116)	(21,377,267)	(11,996,767)	(11,590,927)
	Other	26,747	34,329	24,037	31,562	148,525,384	165,456,111	131,309,169	149,647,807	2,957,526	3,316,593	3,036,097	3,410,043
	Outdoor Lighting	5	111	4	98	22,002,020	21,159,485	17,535,017	14,753,705	(665)	(665)	(572)	(572)
	Plug Loads	444	443	103	102	18,058,651	18,052,897	2,912,339	2,909,569	(439,546)	(439,407)	(69,175)	(69,091)
	Process	399	239	236	153	3,240,763	2,033,650	1,888,268	1,277,638	687	687	536	536
	Refrigeration	695	695	568	568	2,716,933	2,716,330	2,189,586	2,188,746	(3,823)	(3,823)	(3,430)	(3,430)
	Water Heating	602	602	390	386	4,122,179	4,122,179	2,763,116	2,715,587	10,105,036	10,062,492	6,397,521	6,166,337
	Whole Building	106,347	107,265	84,992	84,582	315,684,380	360,511,107	287,361,613	327,889,997	13,937,604	14,267,436	12,418,256	12,757,529
	Total	377,149	395,437	272,552	272,635	1,868,687,344	2,015,916,566	1,316,382,105	1,320,094,524	10,637,553	8,708,186	11,343,915	12,213,254
Total		########	966,759	728,061	632,414	5,458,063,060	5,097,853,068	3,894,491,440	3,247,233,510	121,074,019	86,328,882	81,646,736	59,044,431

Table B-4b 2013-2015 Statewide Lifecycle Savings by Sector and End use

		Electric (kWh)				Natural Gas (MMTherms)			
		Gross		Net		Gross		Net	
Sector	End Use	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated
Agriculture	Appliance	896,359	896,359	598,003	598,003	16,627	16,627	11,922	11,922
	Food Service	531,816	531,816	345,680	345,680	347,700	347,700	226,005	226,005
	HVAC	236,751,491	189,198,395	171,702,885	118,956,442	13,185,659	8,993,781	9,923,325	5,154,554
	Indoor Lighting	274,703,559	257,910,255	198,138,096	144,094,981	(157,936)	(155,044)	(106,823)	(103,794)
	Other	70,013,630	39,786,585	45,594,989	21,965,446	-	-	-	-
	Outdoor Lighting	162,940,811	125,346,375	105,263,940	69,739,506	-	-	-	-
	Plug Loads	6,144	6,144	3,994	3,994	(29)	(29)	(19)	(19)
	Process	2,494,642,377	1,755,271,723	1,716,210,122	1,081,302,038	127,457,112	90,460,430	87,593,363	52,782,232
	Refrigeration	450,761,421	312,085,145	326,569,082	182,699,085	67,046	46,183	43,580	25,861
	Water Heating	-	-	-	-	96,852	96,852	62,954	62,954
	Whole Building	72,245,624	53,757,972	58,702,822	28,797,604	791,722	791,722	158,067	158,067
	Total	3,763,493,232	2,734,790,769	2,623,129,614	1,648,502,780	141,804,754	100,598,222	97,912,374	58,317,781
Commercial	Appliance	149,513,052	147,730,194	100,068,251	98,674,129	3,398,025	2,059,712	1,970,684	1,332,764
	Food Service	88,318,612	83,267,007	60,085,871	56,533,072	78,961,417	77,439,976	51,342,797	50,628,888
	HVAC	8,288,945,990	6,053,250,268	6,093,966,830	4,105,766,542	177,027,927	119,485,695	123,474,160	74,812,867
	Indoor Lighting	10,166,657,009	10,553,739,680	7,575,753,896	6,901,042,263	(29,985,562)	(32,910,603)	(22,111,720)	(22,067,677)
	Other	233,403,925	161,441,754	151,857,666	98,274,261	41,263,057	25,782,695	24,580,771	16,889,360
	Outdoor Lighting	2,739,518,501	2,409,892,239	2,048,564,266	1,439,680,337	316,026	138,006	221,488	75,686
	Plug Loads	147,055,934	129,007,735	97,175,647	85,272,718	(155,802)	(146,688)	(107,242)	(101,354)
	Process	1,491,759,019	902,568,152	1,036,096,968	510,137,517	145,071,836	104,945,401	90,411,220	64,173,941
	Refrigeration	2,802,891,174	2,540,685,796	1,972,313,368	1,765,567,826	13,611,381	12,276,861	8,332,506	7,837,427
	Water Heating	9,360,930	8,109,016	5,594,829	4,701,111	84,551,204	80,405,599	56,220,980	53,937,303
	Whole Building	2,066,015,613	1,610,578,205	1,562,531,940	898,436,412	69,325,138	49,597,679	47,580,343	24,089,952
	Total	28,183,439,760	24,600,270,046	20,704,009,534	15,964,086,187	583,384,647	439,074,333	381,915,988	271,609,155
Industrial	Appliance	1,792,348	1,792,348	1,176,150	1,176,150	68,312	43,277	39,674	29,496
	Food Service	1,085,616	1,085,616	705,650	705,650	535,574	369,480	310,430	245,605
	HVAC	1,211,703,687	662,062,415	851,343,378	387,242,444	41,935,746	25,976,321	25,522,982	16,947,997
	Indoor Lighting	767,739,079	747,105,918	588,433,901	464,204,854	(1,238,369)	(1,219,325)	(946,129)	(843,342)
	Other	26,777,375	16,222,511	17,584,168	8,548,026	41,417,197	23,393,759	22,795,606	15,054,135
	Outdoor Lighting	163,210,679	143,781,390	125,738,555	80,739,742	-	-	-	-
	Plug Loads	152,064	152,064	98,842	98,842	3,554,333	1,812,363	1,954,812	1,123,644
	Process	4,526,187,085	2,743,475,986	3,055,020,196	1,588,753,437	600,303,536	386,630,896	380,423,262	242,902,944
	Refrigeration	368,979,458	196,263,879	252,504,186	112,202,380	5,568,108	3,021,368	3,085,714	2,008,603
	Water Heating	-	-	-	-	1,850,204	1,444,336	1,109,362	922,999
	Whole Building	88,973,409	80,123,623	57,676,210	43,666,169	2,022,532	1,472,625	915,387	532,983
	Total	7,156,600,799	4,592,065,751	4,950,281,236	2,687,337,694	696,017,174	442,945,100	435,211,101	278,925,063
Residential	Appliance	1,726,646,967	1,726,646,967	1,055,684,130	1,055,855,846	26,555,102	26,555,102	13,843,452	13,866,304
	Food Service	(530,046)	(530,046)	(318,028)	(318,028)	100,064	100,064	60,038	60,038
	HVAC	782,547,422	759,908,332	581,162,037	561,518,962	31,235,084	31,358,475	19,189,245	18,808,187
	Indoor Lighting	10,425,787,378	12,230,829,878	6,692,319,794	6,424,135,273	(190,769,590)	(229,838,172)	(122,028,986)	(119,419,026)
	Other	601,788,269	619,219,733	406,731,506	430,262,971	4,708,144	5,064,841	4,335,258	4,694,417
	Outdoor Lighting	303,592,426	245,732,328	239,768,968	162,099,871	(9,997)	(9,997)	(8,698)	(8,698)
	Plug Loads	126,259,054	126,213,021	20,269,816	20,247,662	(3,075,767)	(3,074,662)	(483,377)	(482,711)
	Process	32,418,496	15,530,391	20,048,738	9,796,593	8,218	8,218	6,327	6,327
	Refrigeration	38,535,143	38,525,192	30,941,254	30,931,712	(28,165)	(28,165)	(25,209)	(25,209)
	Water Heating	44,874,063	44,874,063	29,708,177	29,238,602	123,856,089	123,051,574	78,106,395	74,834,500
	Whole Building	1,203,915,226	1,111,072,494	942,376,223	818,958,942	123,011,779	110,084,656	92,664,564	79,139,981
	Total	15,285,834,399	16,918,022,352	10,018,692,615	9,542,728,407	115,590,961	63,271,935	85,659,009	71,474,109
Total		54,389,368,190	48,845,148,917	38,296,113,000	29,842,655,067	1,536,797,536	1,045,889,590	1,000,698,472	680,326,109

Appendix C: Emissions Reductions

An Excel file containing the data used in this appendix is available.

A key benefit of energy efficiency programs is the reduction in CO2, NOx, and particulate matter (PM-10) emissions that would have otherwise occurred. The CPUC calculates avoided emissions from electric and gas savings based on an emissions rate specific to type of installed efficient technology. The avoided emissions factors for each technology are embedded in the cost effectiveness tools that Energy Division uses to estimate portfolio impacts. [161]

Electric:	
$ER[CO_2]_M$	**= Emission rate of CO_2 in tons per kWh of measure *M*.**
Gas:	
$ER[CO_2]_{GCT}$	**= Emission rate of CO_2 in tons per therm, based on the gas combustion type (GCT) specified on the input sheet for the measure.**

Table C-1a: Evaluated First Year Emissions Reductions by Program Administrator[162]

		Electric			Gas	
PA		CO2 (1,000 tons)	Nox (pounds)	PM10 (pounds)	CO2 (1,000 tons)	Nox (pounds)
PGE	Gross	2,801,383	692,281	368,051	296,866	466,866
	Net	1,625,680	400,528	213,738	241,447	376,391
SCE	Gross	2,940,289	727,911	386,136	(76,522)	(120,342)
	Net	1,686,812	419,567	221,274	(46,119)	(73,135)
SCG	Gross	20,943	5,386	2,725	417,644	656,808
	Net	12,803	3,296	1,665	209,408	329,678
SDGE	Gross	634,914	155,688	83,569	9,843	15,480
	Net	352,952	86,626	46,446	13,058	21,008
BAY	Gross	3,366	858	439	3,558	5,595
	Net	2,184	556	285	2,737	4,163
MCE	Gross	975	236	129	222	349
	Net	735	178	97	197	310
SCR	Gross	724	182	95	267	420
	Net	434	110	57	163	234
Portfolio	Gross	6,401,871	1,582,359	841,049	651,611	1,024,756
	Net	3,681,165	910,751	483,505	420,728	658,416

[161] CPUC Energy Efficiency Policy Manual Version 5, p.50.
[162] Note: CO2 is reported in 1,000 tons; NOx and PMs are reported in pounds.

Table C-1b: Evaluated Lifecycle Emissions Reductions by Program Administrator

		Electric			Gas	
PA		CO2 (1,000 tons)	Nox (pounds)	PM10 (pounds)	CO2 (1,000 tons)	Nox (pounds)
PGE	Gross	28,442,040	7,063,023	3,732,433	4,219,267	6,635,429
	Net	15,533,308	3,827,769	2,030,981	2,607,448	4,100,603
SCE	Gross	30,662,933	7,609,187	4,024,554	(735,433)	(1,156,579)
	Net	17,229,551	4,280,414	2,250,456	(436,537)	(686,519)
SCG	Gross	267,061	68,852	34,727	6,254,515	9,836,160
	Net	166,649	43,030	21,662	2,912,704	4,580,663
SDGE	Gross	6,782,174	1,665,464	892,384	177,913	279,794
	Net	3,558,560	874,440	468,051	141,284	222,190
BAY	Gross	51,848	13,209	6,762	59,330	93,306
	Net	36,288	8,765	4,487	45,090	70,911
MCE	Gross	12,026	2,915	1,587	3,028	4,761
	Net	9,118	2,210	1,203	2,712	4,265
SCR	Gross	10,855	2,739	1,419	4,170	6,558
	Net	5,780	1,672	864	2,389	3,758
Portfolio	Gross	66,228,938	16,425,391	8,693,867	9,982,789	15,699,429
	Net	36,539,255	9,038,300	4,777,704	5,275,091	8,295,869

Appendix D: Cost-Effectiveness Results

An Excel file containing the data used in this appendix is available.

The California Energy Efficiency Policy Manual defines cost effectiveness as *"an indicator of the relative performance or economic attractiveness of any energy efficiency investment or practice when compared to the costs of energy produced and delivered in the absence of such an investment.*[163]*"*

The CPUC requires that all energy efficiency portfolios provide positive net benefits based on two cost effectiveness tests: the Total Resource Cost test (TRC) and the Program Administrator Cost test (PAC). Since the TRC costs are generally greater than PAC costs, in practice this dual requirement results in the TRC being the primary indicator of energy efficiency program cost effectiveness.

When looking at evaluated savings, every dollar invested in energy efficiency through the IOUs' 2013-2015 energy efficiency programs, excluding savings from codes and standards, resulted in $0.87 in benefits through the TRC test "lens," and $1.28 in benefits based on the PAC test lens. The definition of each of these cost effectiveness tests and how they are used to evaluate the cost effectiveness of the portfolio are discussed in this appendix.

For this report, the SQL based cost effectiveness tool (CET_17.3.0) was used for the evaluated portfolio-level analysis and cost effectiveness calculations. The CET calculates cost effectiveness on the portfolio and programs using methodologies adopted in the California Standard Practice Manual – Economic Analysis of Demand-Side Programs and Projects.[164] Cost effectiveness is calculated using lifecycle cost-benefit ratios to produce total resource cost (TRC) and program administrator cost (PAC) ratios. These ratios are based on the net present value of benefits, determined by avoided cost methodology[165], divided by net present value of costs.

Cost-Effectiveness Tests

The TRC measures the net resource benefits to all ratepayers by combining the net benefits of the program to participants and nonparticipants. The benefits are the avoided costs of the supply-side resources that are either avoided or deferred by the energy savings. The TRC costs encompass the cost of the measures or equipment installed by the customer, as well as the costs incurred by the program administrator for both resource and non-resource program activities.

$$\textbf{TRC} = \frac{\textbf{Benefits} = \text{Net Present Value of avoided costs of supply-side resources avoided}}{\begin{array}{l}\textbf{Costs} = \text{Net Present Value of Measure Costs paid by participants and program administrators} \\ \quad + \text{non-rebate costs incurred by program administrators}\end{array}}$$

The PAC test measures program benefits in the same way the TRC test does. However, only those costs incurred by the program administrator are included (i.e., measure costs paid by the participating customers are not included).

[163] Energy Efficiency Policy Manual, Version 4; p2, http://www.calmac.org/events/EE_Policy_Manual_v4_0.pdf
[164]Available at http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=7741
[165] Available at: https://ethree.com/public_projects/cpuc5.php

$$\textbf{PAC} = \frac{\textbf{Benefits} = \text{Net Present Value of avoided costs of supply-side resources avoided}}{\textbf{Costs} = \text{Net Present Value of all costs incurred by program administrators}}$$

This report provides portfolio- and program-level cost effectiveness estimates. It is difficult to disaggregate the benefits and costs to specific measure or market sector levels in a meaningful way, so the lowest granularity of cost-effectiveness calculations are done at the program level. Table D-1 presents the cost effectiveness of the portfolios as a whole; program-level cost effectiveness results are provided in Tables D-4 through D-10. The costs included in the TRC test remove the measure costs to free-rider participants, since the benefits associated with those participants are excluded as well.

Table D-1: IOU Reported and Commission Evaluated Cost Effectiveness – with and without Codes & Standards (C&S)

		Reported						Evaluated		
IOU	CE Test	Benefit (M$)	Cost (M$)	Ratio	Benefit w/C&S (M$)	Cost w/C&S (M$)	Ratio (w/C&S)	Benefit no C&S (M$)	Cost no C&S (M$)	Ratio-no C&S
PGE	TRC	1,988	1,479	1.34	3,159	1,833	1.72	1,422	1,466	0.97
	PAC	1,988	1,027	1.94	3,159	1,052	3.00	1,422	1,027	1.38
SCE	TRC	1,485	1,486	1.00	2,718	1,556	1.75	1,185	1,450	0.82
	PAC	1,485	933	1.59	2,718	947	2.87	1,185	933	1.27
SCG	TRC	307	289	1.06	482	312	1.54	256	289	0.89
	PAC	307	180	1.70	482	182	2.65	256	180	1.42
SDGE	TRC	339	377	0.90	601	442	1.36	283	383	0.74
	PAC	339	253	1.34	601	255	2.36	283	253	1.12
BAY	TRC	25	47	0.53	25	51	0.49	17	47	0.35
	PAC	25	31	0.82	25	34	0.72	17	31	0.54
MCE	TRC	2	4	0.47	2	4	0.47	2	4	0.48
	PAC	2	3	0.60	2	3	0.60	2	3	0.60
SCR	TRC	4	46	0.10	4	46	0.10	2	51	0.04
	PAC	4	42	0.11	4	42	0.11	2	42	0.05
Portfolio	TRC	4,151	3,630	1.14	6,990	4,243	1.65	3,166	3,689	0.86
	PAC	4,151	2,393	1.73	6,990	2,514	2.78	3,166	2,469	1.28

Cost Effectiveness of the 2013-2015 Programs

Energy efficiency program impact evaluations conducted by the CPUC do not include analysis of program or measure costs or cost effectiveness. The cost effectiveness results presented in this appendix are calculated based on the monetized benefits of the evaluated net energy savings, compared to the incentive and program costs according to the California Standard Practice Manual. In D.12-11-015, the CPUC adopted a portfolio level "market effects adjustment" of 5 percent across the board for the entire 2013-2014 portfolio cost effectiveness calculation. This policy was carried through into 2015. D.14-10-046 also reduced the cost effectiveness threshold for 2015 to account for budget changes thought to have an adverse effect on TRC, and to discourage fund shifting within the portfolios in an effort to increase the TRC.

Context of the Results

The cost effectiveness rules that guide California energy efficiency planning and evaluation are outlined in more detail in the California Standard Practice Manual. These rules are embedded in the cost effectiveness

calculators that are used for reporting program accomplishments and planning programs. The rules reflect current Commission policy for assessment of the cost effectiveness of these program activities.

Certain limitations with incremental measure cost data affected the accuracy of the cost effectiveness calculations presented here. These include data quality issues associated with program tracking data as well as deemed estimates for incremental costs that are out of date and may have led to both over- and under-estimates of the incremental measure costs. The largest error has been corrected, as noted above, and corrections at the measure level will be made in the future.

Likewise, the long-term savings benefits may not be accurately reflected by the simple extrapolation of first year energy savings over the expected useful life of the technology. The "dual baseline" effects can both over- and under-estimate long-term savings and consequently distort the real value of the resource. Dual baselines were captured in the 2013-2015 cost effectiveness calculator and were modeled for the non-residential lighting and other program areas where appropriate.

The benefits for these programmatic activities do not consider the potential long-term market effects of the energy efficiency programs. Similarly, short term participant or non-participant spillover effects were not included in the 2013-2015 program period but will be included in the 2013-2014 program cycle savings for the first time. Long term market effects can include program effects on end user decision making (e.g. changes in knowledge and awareness), trade ally practices (e.g., changes in product availability and marketing), and changes in energy efficiency and product and service characteristics (e.g. changes in product costs and features). The primary focus of the 2010-2012 impact evaluations was on the estimation of the immediate and direct impacts of the 2010-2012 programs and the cost benefit calculations reflect those requirements. While the inclusion of market-driven effects could result in higher benefit-cost (B/C) ratios it could also result in a lower level of estimated net savings for utility programs even though total societal savings from both utility program and market forces are significant.

Appendix E: Program Level Detail – Net Lifecycle kW, kWh, Therms

An Excel file containing the data used in this appendix is available.

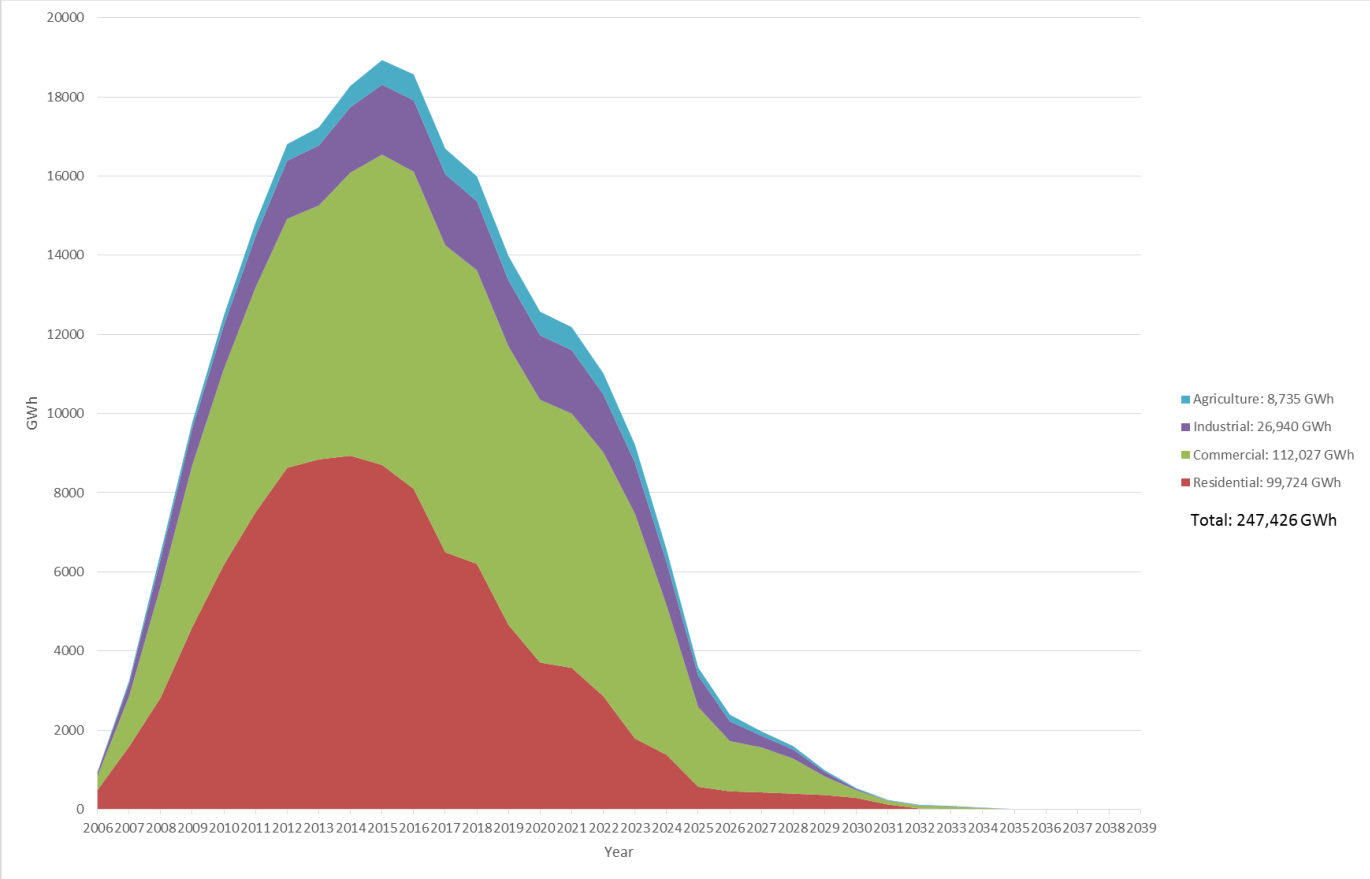
Throughout the report, references to savings are referring to first year savings; however, measures continue to provide savings throughout their useful lives. Tables showing the net lifecycle savings, kW, kWh and Therms, cost effectiveness and emissions reductions for all programs measures installed in 2013-2015 and lasting through 2035 are available in the Appendix E excel file.

Appendix F: Ex-Post Gross Lifecycle Savings by Sector, GWh, MMTherms

An Excel file containing the data used in this appendix is available.

Throughout the report, references to savings are generally referring to first year savings; however, measures continue to provide savings throughout their useful lives. In particular, grid planning activities are informed by understanding the full lifetime impact of all energy efficiency savings, not just the savings attributable to program administrator efforts. The following graphics show evaluated gross lifetime savings (GWh, and Therms) for energy efficiency measures installed between 2006-2015 and the total impacts of installed energy efficiency through 2035.

Figure F-1a: Statewide Ex Post Gross Lifecycle Savings (GWh) 2006-2015



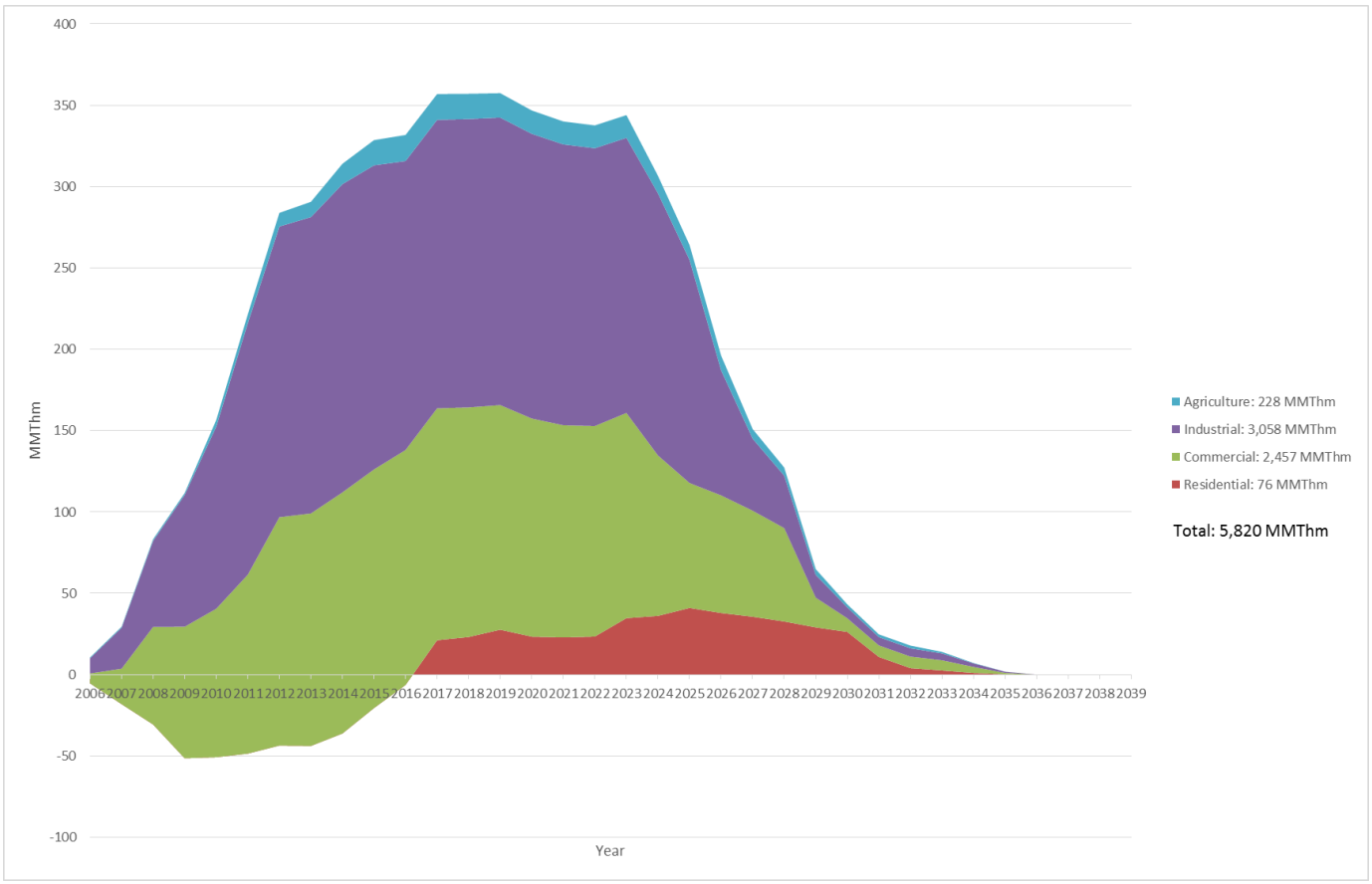


Figure F-1b: Statewide Ex Post Gross Lifecycle Savings (MM Therms) 2006-2015

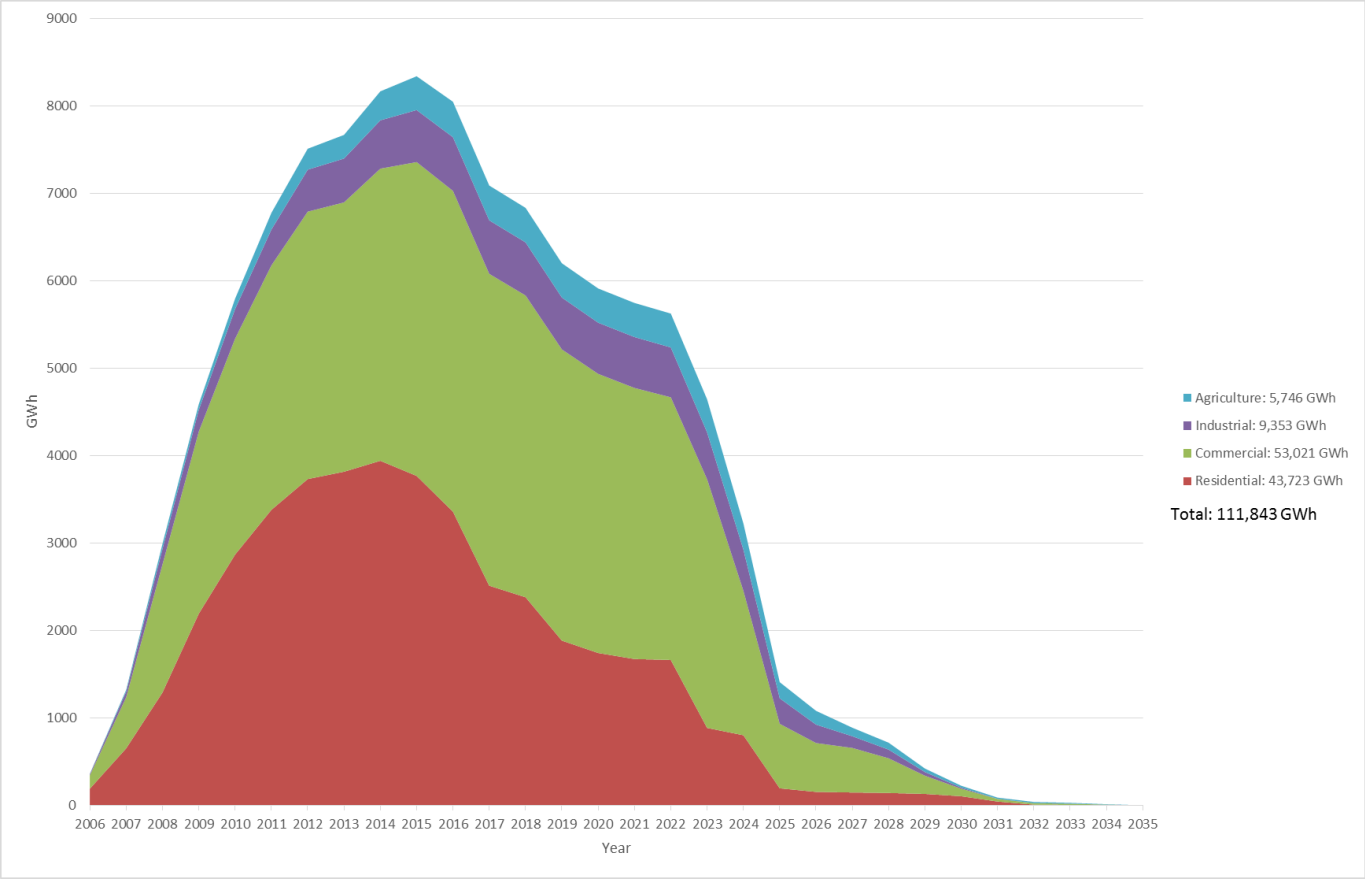


Figure F-2a: PG&E Ex Post Gross Lifecycle Savings (GWh) by Sector 2006-2015

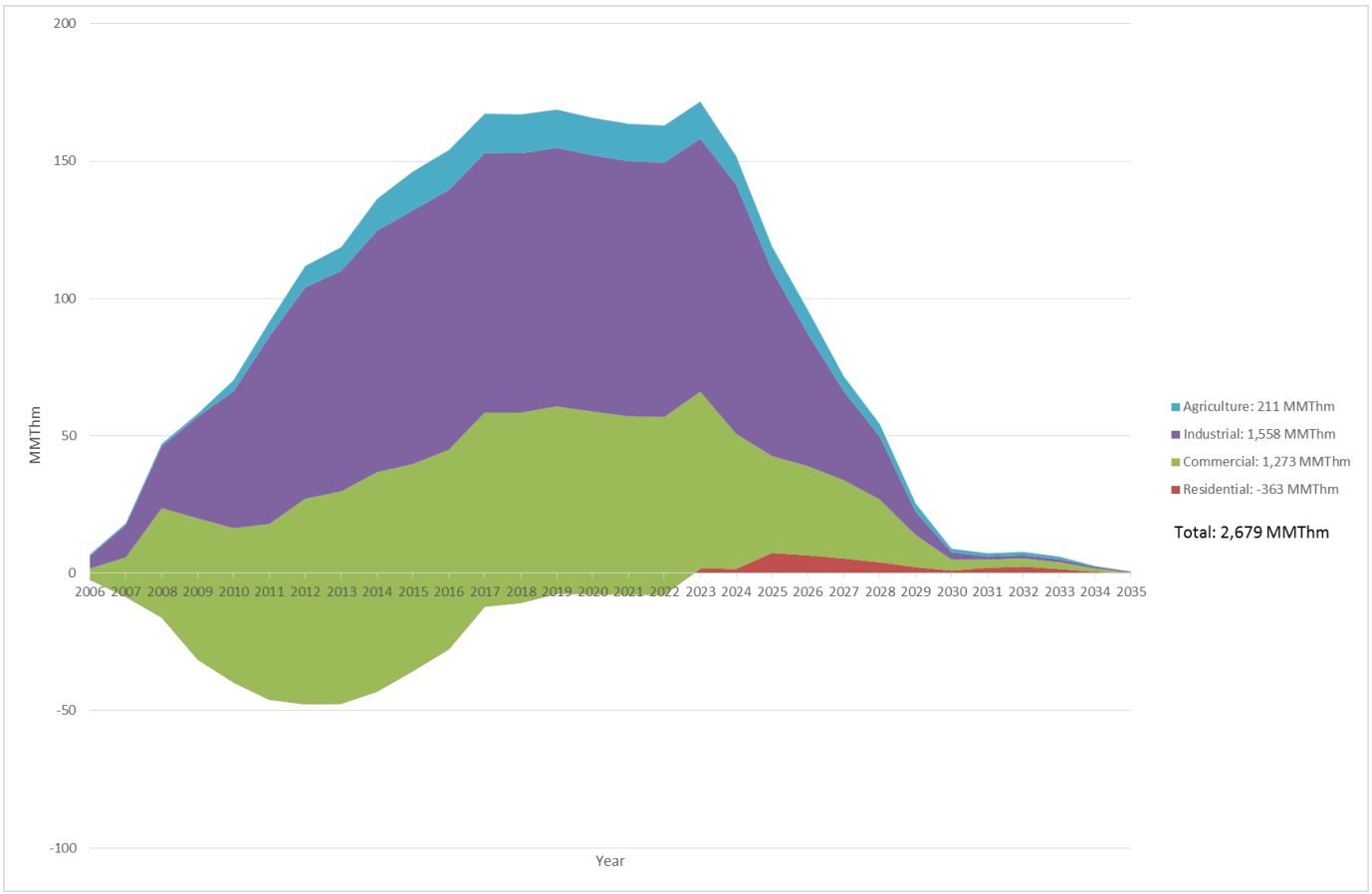


Figure F-2b: PG&E Ex Post Gross Lifecycle Savings (MM Therms) by Sector 2006-2015

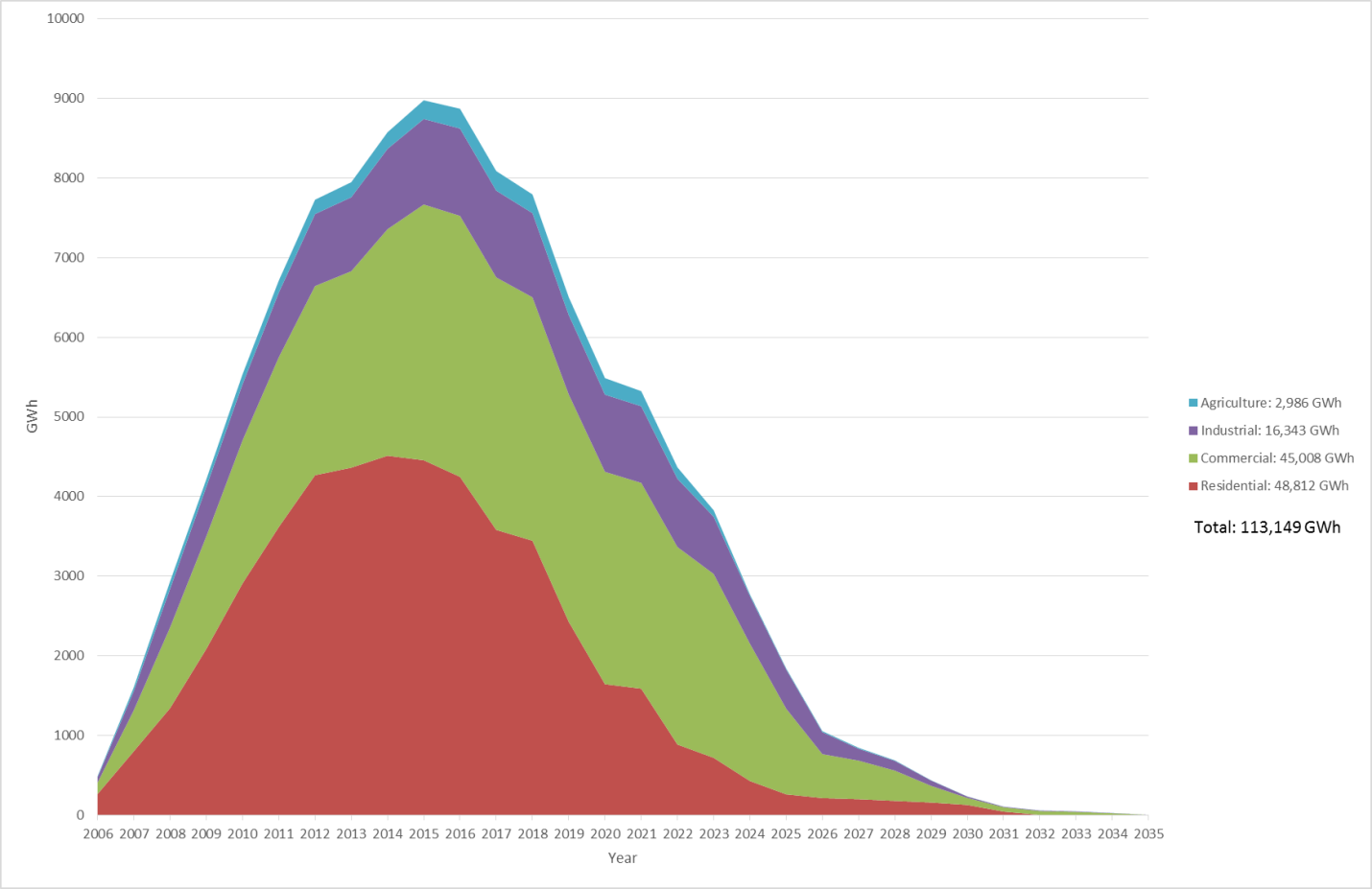


Figure F-3: SCE Ex Post Gross Lifecycle Savings (GWh) 2006-2015

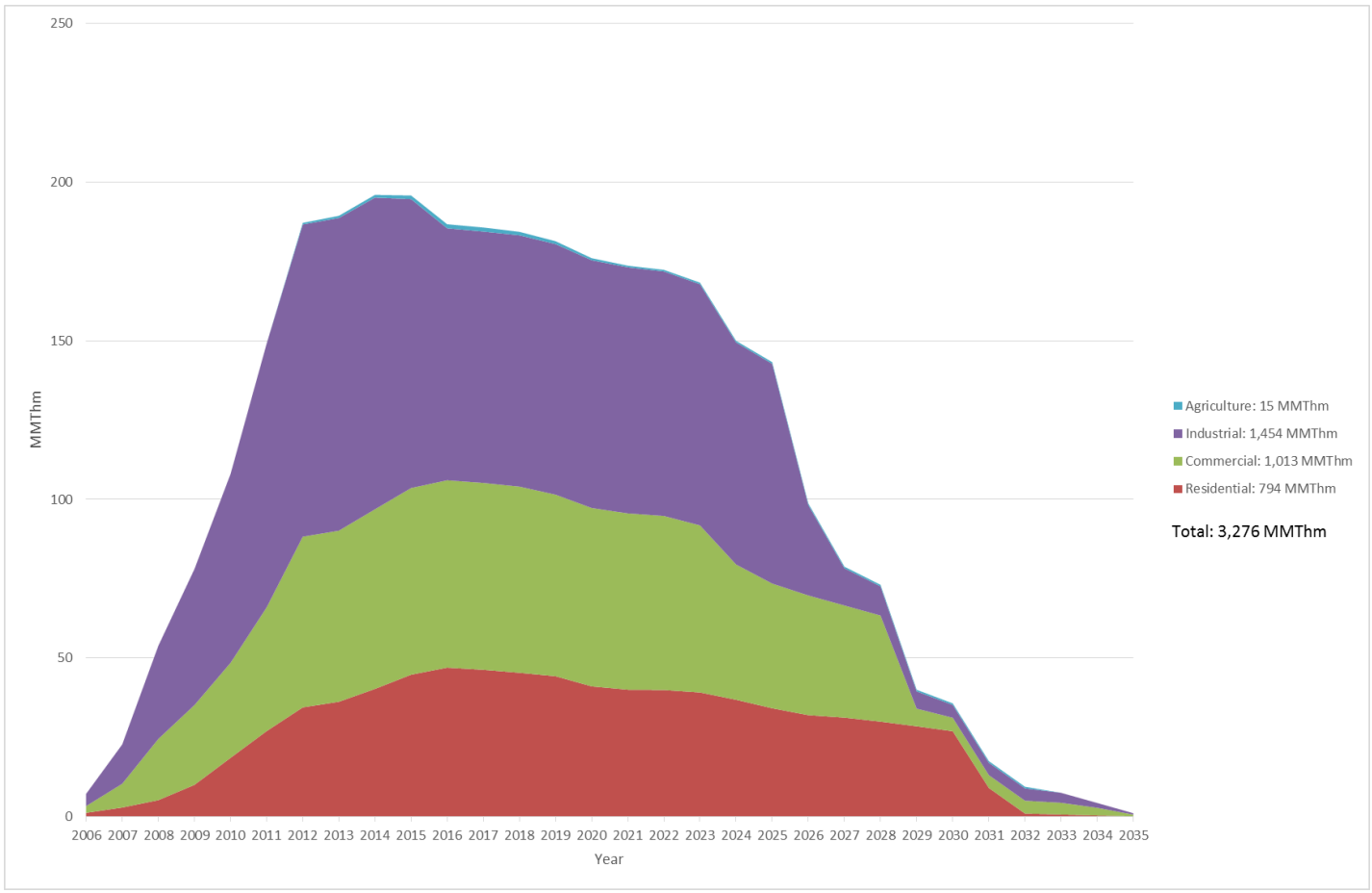


Figure F-4: SoCalGas Ex Post Gross Lifecycle Savings (MM Therms) 2006-2015

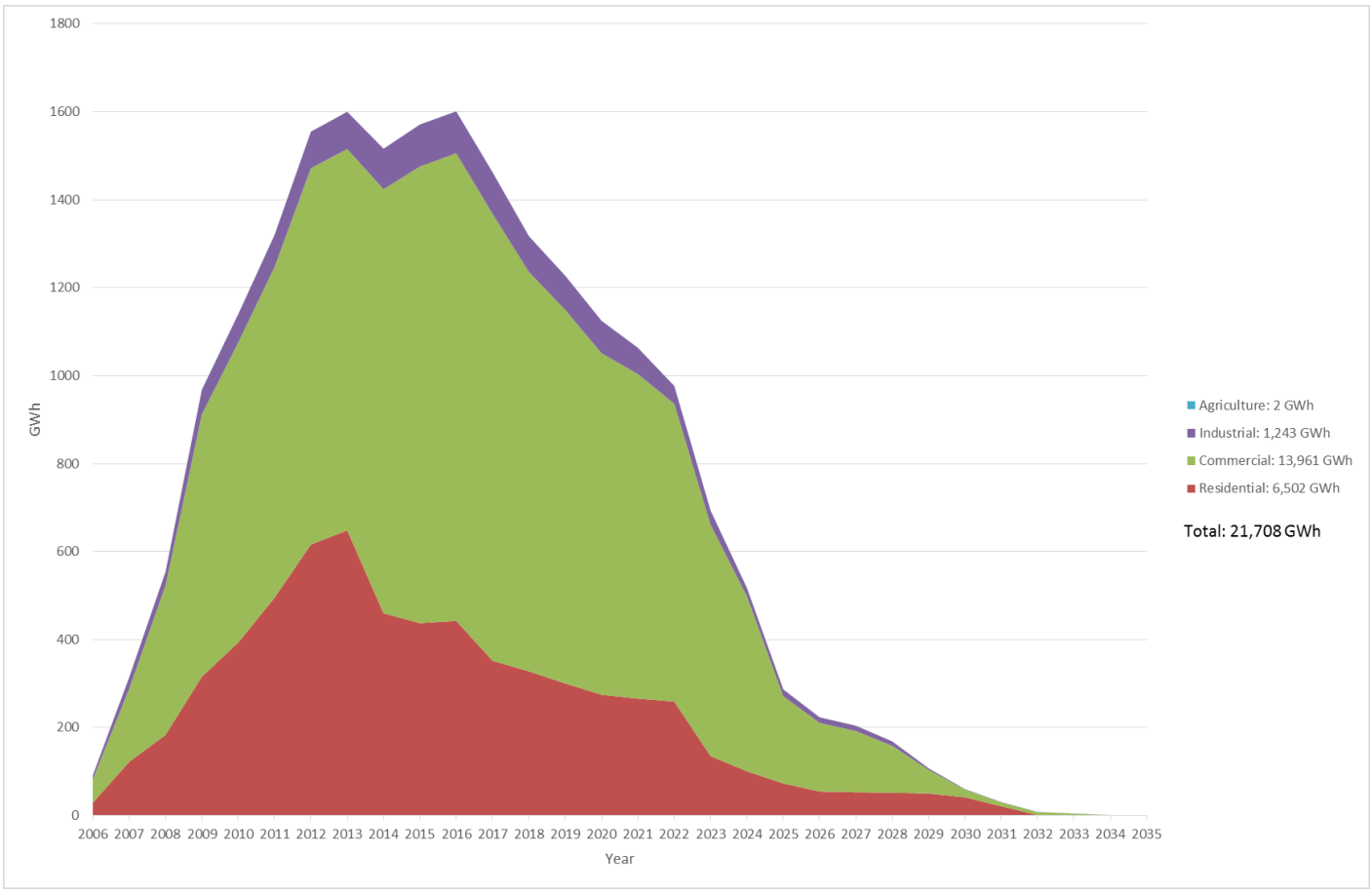


Figure F-5a: SDG&E Ex post Gross Lifecycle Savings (GWh) 2006-2015

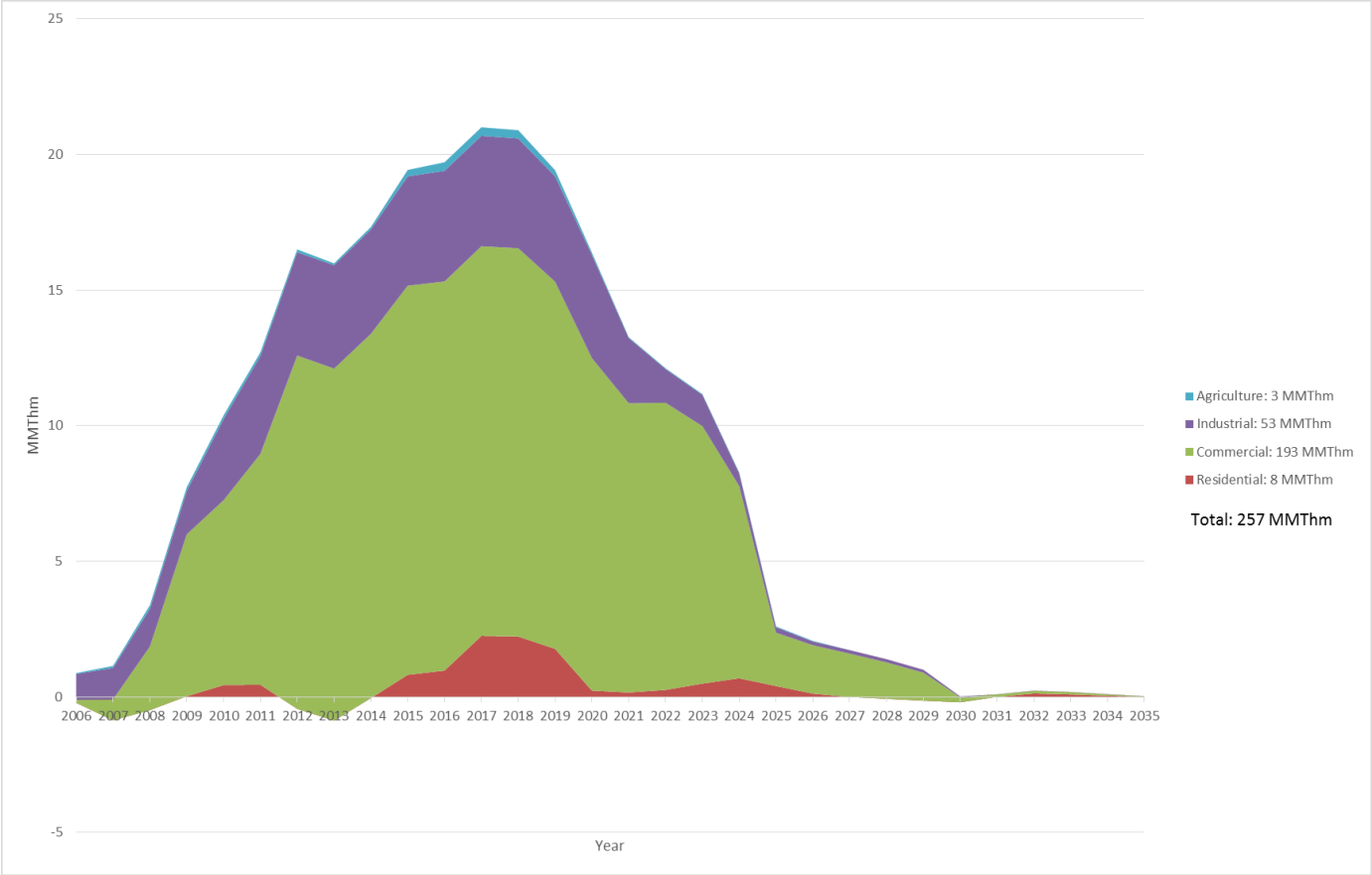


Figure F-5b: SDG&E Ex Post Gross Lifecycle Savings (MM Therms) 2006-2015

Appendix G: Processing and Updating Utility Claim Data with Evaluation Results Data

The energy efficiency program tracking data forms the basis for program reporting and for evaluation studies. Over the course of the 2013-2015 program cycle, the CPUC and the PAs collected all reported savings values in a set of relational tables that were referenced by quarterly PA claims. This data set is the foundation for the values in this report. It was compared and reconciled against the monthly and annual savings reports submitted by the PAs.

Working closely with Energy Division staff and consultants throughout the 2013-2015 program cycle, the PAs were able to submit standardized quarterly claims data along with corresponding ex-ante data tables. Despite improvements to standardization, the central data set still required some level of manual data cleaning to enable processing through the cost effectiveness tool.[166] The steps for cleaning and processing the PA submitted data are described in this appendix.

Preparation of PA Quarterly Tracking Data for Reporting

Each quarter of the calendar year, the following steps are performed to process PA reported savings data. Figure G-1 is an illustration of the process.

PA Claim Submissions (CPUC)

Step 1. Receive FTP link to download data from PAs

Step 2. Write PA data together into standardized tables

Step 3. Join claim tables to the ex-ante database for deemed claims; write data into "EDFilled" table

Step 4. Quality check the data submission

Step 5. Post PA data submissions and "EDFilled" table onto ED Central Server (EDCS) and into SQL Server database

Evaluation Results Submissions (CPUC)

Step 1. Post impact evaluation report specific databases to EDCS SmartFile for evaluation teams

Step 2. Evaluation team posts filled out claim-level evaluation data submission to EDCS SmartFile

Step 3. Quality check individual data submissions and iterate with evaluation teams

Step 4. Read together all evaluation results and create 13-15 ATR Evaluation SQL Server database

Cost Effectiveness Run (CPUC)

Step 1. Run EDFilled and Evaluation table through the Cost Effectiveness Tool (CET)

[166] Subsequent to the 2013-2015 program cycle, the Energy Division developed a customized software to automatically enforce data rules for quarterly claims and monthly reports; this is known as the California Energy Data and Reporting System (CEDARS).

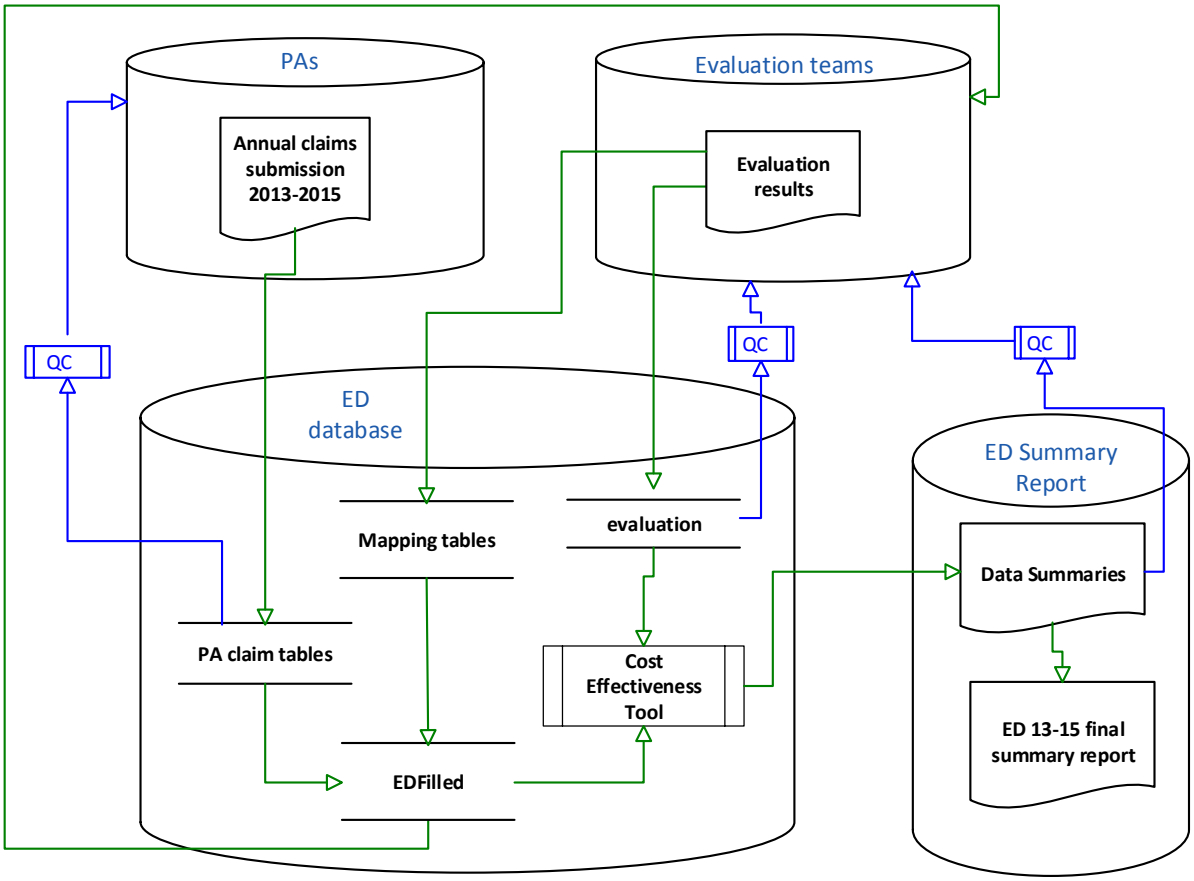
Step 2. Write CET results into SQL Server database

Step 3. Validate and quality check CET results against SQL savings calculations

Report Preparation (CPUC)

Final step. Summarize data to produce result sets for Energy Division staff to use in evaluated program cycle reporting.

Figure G-1: Claims Processing



Data Cleaning

Data elements such as Target Sector, Climate Zone, Costs, and other parameters that were necessary for evaluation and for cost-effectiveness calculations were cleaned by CPUC evaluation contractors in conjunction with PA staff. Throughout the cycle, the amount of data cleaning necessary was continuously reduced as PAs improved their reporting capabilities. The result of the data cleaning process was a table named "EDFilled," which contains all cleaned ex-ante PA data necessary to run through the CET.

Validation and Quality Control

The main component of the Energy Division's data cleaning process was a quality control algorithm. All quality control algorithms were communicated to the PAs via the Data Transfer Tool, a Microsoft Access file that the PAs use to transfer their quarterly tracking data to the Energy Division. The PAs also use this file to perform quality control on their own data before transferring. The end-product was a clean, consistent data set of claims that were ready for evaluation sampling, update, and CET processing. The link to this tool on EEStats is:

http://eestats.cpuc.ca.gov/EEGA2010Files/GuidanceDocuments/Claim_Tables_2015_Q1_revised20150602.zip

Appendix H: Evaluation Decision Framework

Commission staff used the quarterly tracking data as the foundation for prioritizing evaluation activities and applying updates from evaluation work. The 2013-2015 ESPI impact evaluation reports carried out CPUC staff's guidance to make updates to the claims on a savings realization rate basis. CPUC staff and evaluation contractors used the following options in making updates to the PA savings claims:

1. Pass through: provide no update to reported savings values for claims that do not fall within the frame of an impact evaluation (no change)
2. Apply results from the 2013-2015 impact evaluation studies: Apply evaluation report provided claim level results to records included in the frame of an impact evaluation.

The decision tree in Figure H1 illustrates how CPUC staff partitioned claims for the purposes of resource program savings evaluation results application. The figure is based upon section 7 of D.13-09-023.

Impact Evaluation Reports

Impact evaluation reports were submitted by the two main evaluation contractors, DNV-GL and Itron, but also included other subcontractors, Apex Analytics and ERS. Each final evaluation report was reviewed and vetted via the public review process and the final numbers were provided to the data processing team. Evaluation impact results are summarized and uploaded to the Energy Division SmartFile data repository and downloaded and processed into the SQL Server database on the Energy Division Central Server (EDCS). EDCS is an internal server used to manage the data. It is not accessible to the public. Table lists all impact evaluations by year and provides links to download each report.

Table H-1: Impact Evaluation Reports by Program Year(s) Studied

Program Year(s)	Impact Evaluation Reports
2013	2013 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
	2013 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
	2013 Nonresidential Downstream Deemed ESPI Net-to-Gross Evaluation For Sprinkler and Pipe Insulation Measures
	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
	2013 PG&E Home Energy Reports Program Review and Validation of Impact Evaluation ED Res 3.1
	IALC4 NRNC Whole Building Impact Evaluation Report PY-2013
	SDG&E Home Energy Reports Program 2013 Impact Evaluation ED Res 3.3
	2014 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
2014	2014 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
	2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
	2014 Nonresidential Downstream Deemed ESPI pipe Insulation Impact Evaluation Report
	2014 Nonresidential Downstream Deemed Plug Load PC Power Management Software ESPI Impact Evaluation Report
	2014 Nonresidential Downstream Deemed ESPI Low-Pressure Sprinkler Nozzle Impact Evaluation Report
	Impact Evaluation of 2014 San Diego Gas & Electric Home Energy Reports Program (Final Report)

	Review and Validation of 2014 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
	Review and Validation of 2014 Southern California Edison Home Energy Reports Program Impacts (Final Report)
	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
2013-2014	Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
	Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
	Impact Evaluation of 2013-2014 SDG&E Residential VSD Pool Pump Program
	Net-to-gross Evaluation of 2013-14 Commercial Quality Maintenance Programs (HVAC3)
	Net-to-gross Evaluation of 2013-14 Upstream HVAC Programs (HVAC 1)
	2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
2015	2015 Custom Impact Evaluation Industrial, Agriculture and Large Commercial
	2015 Nonresidential Downstream ESPI Deemed Pipe Insulation Impact Evaluation
	2015 Nonresidential Downstream ESPI Deemed Pool Cover Impact Evaluation
	2015 Nonresidential Downstream ESPI Deemed Sprinkler Impact Evaluation
	2015 Nonresidential ESPI Custom Lighting Impact Evaluation
	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
	2015 SCE HEES Impact Evaluation
	2015 Single-family Home Energy Upgrade Impact Evaluation*
	2015 Upstream and Residential Downstream Lighting Programs
	Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)
	Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports Program (Final Report)
	Impact Evaluation of 2015 Upstream HVAC Programs (HVAC 1)
	Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
	Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report)

As mentioned above, the main driver for impact evaluations during the 2013-2015 program years was the ESPI mechanism. The two portions of the ESPI Ex-Post Savings Incentive were the Ex-Post Custom and Ex-Post Deemed. The Ex-Post Deemed portion of the portfolio is identified by the Uncertain Measure List, which was constant for 2013-2014, but changed in 2015 and will change each year moving forward. The following table list the ESPI Ex-Post classification grouping, the Uncertain Measures defined for each program year, and each ESPI impact evaluation report that provided evaluation results for this classification.

Table H-2: Ex-Post Targeted ESPI Classifications and Uncertain Measures and Evaluation Reports

Program Year(s)	ESPI Ex-Post Class	Uncertain Measure	Impact Evaluation Report(s)
2013-2014	ESPI Ex-Post Custom	NA	2013 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report

			2013 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
			2014 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			IALC4 NRNC Whole Building Impact Evaluation Report PY-2013
			Review and Validation of 2014 Southern California Edison Home Energy Reports Program Impacts (Final Report)
			SDG&E Home Energy Reports Program 2013 Impact Evaluation ED Res 3.3
			Impact Evaluation of 2014 San Diego Gas & Electric Home Energy Reports Program (Final Report)
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
			Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
	ESPI Ex-Post Deemed	CFL	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
		Computer Power Mgt	2014 Nonresidential Downstream Deemed Plug Load PC Power Management Software ESPI Impact Evaluation Report
		De-lamping	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
		Home Energy Reports	2013 PG&E Home Energy Reports Program Review and Validation of Impact Evaluation ED Res 3.1
			Review and Validation of 2014 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
		Home Energy Surveys	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
			Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
		Home Energy Upgrade	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
			Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
		HVAC Mini	Net-to-gross Evaluation of 2013-14 Upstream HVAC Programs (HVAC 1)
		HVAC Quality	Net-to-gross Evaluation of 2013-14 Commercial Quality Maintenance Programs (HVAC3)

		LED	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
		LED Nightlights	Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
		Occupancy	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
		Pipe Insulation	2013 Nonresidential Downstream Deemed ESPI Net-to-Gross Evaluation For Sprinkler and Pipe Insulation Measures
			2014 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report
		Pool Pumps	Impact Evaluation of 2013-2014 SDG&E Residential VSD Pool Pump Program
		Sprinklers	2013 Nonresidential Downstream Deemed ESPI Net-to-Gross Evaluation For Sprinkler and Pipe Insulation Measures
			2014 Nonresidential Downstream Deemed ESPI Low-Pressure Sprinkler Nozzle Impact Evaluation Report
		T5 Linear Fluorescents	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
		Water Kits	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
2015	ESPI Ex-Post Custom	NA	2015 Nonresidential ESPI Custom Lighting Impact Evaluation
			Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)
			2015 Custom Impact Evaluation Industrial, Agriculture and Large Commercial
			Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report)
			Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports Program (Final Report)

			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
			2015 Single-family Home Energy Upgrade Impact Evaluation*
	ESPI Ex-Post Deemed	CFL > 30W	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2015 Upstream and Residential Downstream Lighting Programs
		De-lamping	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
		Home Energy Reports	Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
		Home Energy Survey	2015 SCE HEES Impact Evaluation
		Home Energy Upgrade	2015 Single-family Home Energy Upgrade Impact Evaluation*
		HVAC Mini	Impact Evaluation of 2015 Upstream HVAC Programs (HVAC 1)
		HVAC Quality	Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		LED	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2015 Upstream and Residential Downstream Lighting Programs
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		LED Outdoor	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		LED Streetlights	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
		Occupancy Sensors	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		Pipe Insulation	2015 Nonresidential Downstream ESPI Deemed Pipe Insulation Impact Evaluation
		Pool Covers	2015 Nonresidential Downstream ESPI Deemed Pool Cover Impact Evaluation
		Sprinklers	2015 Nonresidential Downstream ESPI Deemed Sprinkler Impact Evaluation
		Water Kits	2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report

In contrast to prior program cycles, evaluation results data for the 2013-2015 program cycle were provided by the lead evaluators in a similar format to that provided by the PAs. First, the claims data for each program year was partitioned into separate impact evaluation reports. Next, impact evaluation teams were responsible

for providing claim level results to the data processing team using a standardized template. The data processing team performed many quality checks, however, in addition, the standardized data template was used for automated generation of the Impact Evaluation Standardized Reporting (IESR) appendices printed in each impact evaluation report. These appendix tables served as a quality check for the impact evaluation teams. This information is used to generate the ex-post dataset.

The final processing step covers submission of all raw and processed evaluation data, analysis and processing code, and field tracking data to the online Energy Division data library. The data library is maintained by Energy Division for future reference for evaluation activities and for savings estimation analysis (i.e. ex ante values for work papers or DEER updates).

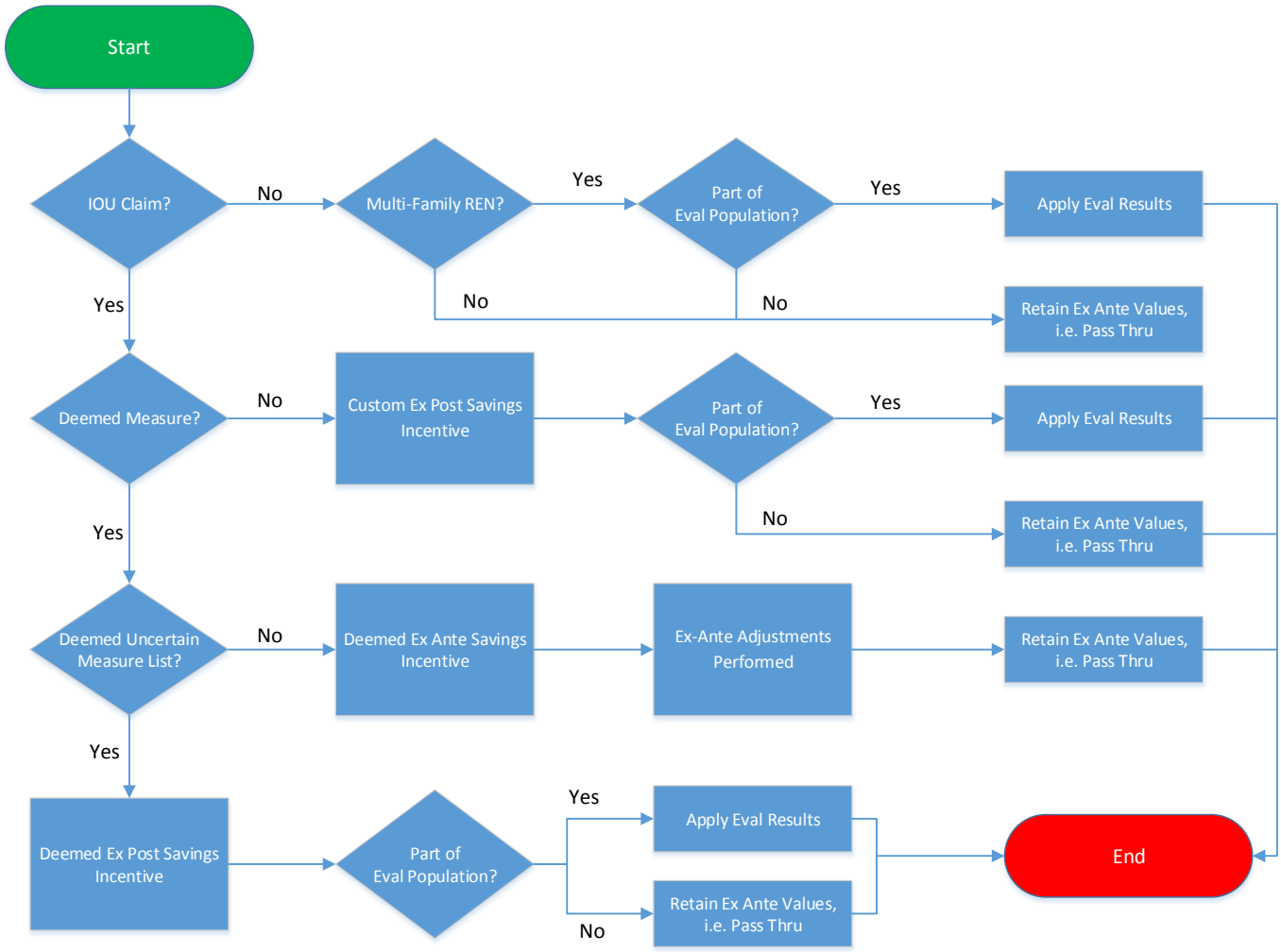
Creation of Ex-Post Dataset

The payments from the ESPI mechanism are driven by a combined 2013-2015 ex post dataset. This dataset contains both ex ante and ex post savings values as well as all parameters necessary for their calculations. The basis of the ex post dataset are the quarterly tracking data claims (described in detail in Appendix G). Once the claims have been submitted by the PAs to the CPUC, and passed all quality control checks, they form the ex ante portion of the ex post database. The ex post portion of the dataset is provided by the previously mentioned ex post evaluations. These ESPI impact evaluation reports, overseen by the CPUC, were performed on custom measures and specific deemed measures with uncertain ex ante parameter values.

Each ex ante claim submitted throughout 2013-2015 was assigned to an individual impact evaluation report where appropriate. Each claims subject to ex post evaluation was assigned to exactly one evaluation report. Then an impact evaluation specific database was generated and posted to Energy Division Central Server (EDCS) Smartfile for each evaluation teams to fill out claim level evaluation results. These databases were filled out by evaluators, and posted in return on EDCS Smartfile. All databases complete with ex post results, were then downloaded and run through iterative and through quality control checks to verify consistent and accurate results. All impact evaluation specific databases are combined with each other and those claims not subject to ex post evaluation to create a final ex post database.

Each claim was identified as either being available for ex post evaluation or not. The following decision tree shows how ED staff determined the situations in which a claim was classified.

Figure H-1: Evaluation Framework Decision Tree



Impact Evaluation Reports

Evaluation reports were submitted by the two main evaluation teams, DNV-GL and Itron, including other subcontractors, Apex Analytics and ERS. Approximately, 12 impact evaluations submitted results per year for the 13-15 program cycle. Each final evaluation report was reviewed and vetted via the public review process and the final numbers were provided to the data processing team. Evaluation impact results are summarized and uploaded to the Energy Division SmartFile data repository and downloaded and processed into the SQL Server database on the Energy Division Central Server (EDCS) an internal server (not publicly available) used to manage the data. Table lists all impact evaluations for which results were integrated into the portfolio claim level savings and provides links to download each report.

Table H-3: Impact Evaluation Reports by Program Year(s) Studied

Program Year(s)	Impact Evaluation Reports
2013	2013 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
	2013 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
	2013 Nonresidential Downstream Deemed ESPI Net-to-Gross Evaluation For Sprinkler and Pipe Insulation Measures
	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
	2013 PG&E Home Energy Reports Program Review and Validation of Impact Evaluation ED Res 3.1
	IALC4 NRNC Whole Building Impact Evaluation Report PY-2013
	SDG&E Home Energy Reports Program 2013 Impact Evaluation ED Res 3.3
	2014 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
2014	2014 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
	2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
	2014 Nonresidential Downstream Deemed ESPI pipe Insulation Impact Evaluation Report
	2014 Nonresidential Downstream Deemed Plug Load PC Power Management Software ESPI Impact Evaluation Report
	2014 Nonresidential Downstream Deemed ESPI Low-Pressure Sprinkler Nozzle Impact Evaluation Report
	Impact Evaluation of 2014 San Diego Gas & Electric Home Energy Reports Program (Final Report)
	Review and Validation of 2014 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
	Review and Validation of 2014 Southern California Edison Home Energy Reports Program Impacts (Final Report)
	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
2013-2014	Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
	Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
	Impact Evaluation of 2013-2014 SDG&E Residential VSD Pool Pump Program
	Net-to-gross Evaluation of 2013-14 Commercial Quality Maintenance Programs (HVAC3)
	Net-to-gross Evaluation of 2013-14 Upstream HVAC Programs (HVAC 1)
	2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
2015	2015 Custom Impact Evaluation Industrial, Agriculture and Large Commercial
	2015 Nonresidential Downstream ESPI Deemed Pipe Insulation Impact Evaluation
	2015 Nonresidential Downstream ESPI Deemed Pool Cover Impact Evaluation
	2015 Nonresidential Downstream ESPI Deemed Sprinkler Impact Evaluation
	2015 Nonresidential ESPI Custom Lighting Impact Evaluation
	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
	2015 SCE HEES Impact Evaluation
	2015 Single-family Home Energy Upgrade Impact Evaluation*
	2015 Upstream and Residential Downstream Lighting Programs
	Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)
	Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports Program (Final Report)

	Impact Evaluation of 2015 Upstream HVAC Programs (HVAC 1)
	Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
	Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report)

As mentioned above, the main driver for impact evaluations during the 2013-2015 program years was the ESPI mechanism. The two portions of the ESPI Ex-Post Savings Incentive were the Ex-Post Custom and Ex-Post Deemed. The Ex-Post Deemed portion of the portfolio is identified by the Uncertain Measure List, which was constant for 2013-2014, but changed in 2015 and will change each year moving forward. The following table list the ESPI Ex-Post classification grouping, the Uncertain Measures defined for each program year, and each ESPI impact evaluation report that provided evaluation results for this classification.

Table H-4: Ex-Post Targeted ESPI Classifications and Uncertain Measures and Evaluation Reports

Program Year(s)	ESPI Ex-Post Class	Uncertain Measure	Impact Evaluation Report(s)
2013-2014	ESPI Ex-Post Custom	NA	2013 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Custom ESPI Lighting Impact Evaluation Report
			2013 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
			2014 Custom Impact Evaluation Industrial, Agricultural, and Large Commercial
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			IALC4 NRNC Whole Building Impact Evaluation Report PY-2013
			Review and Validation of 2014 Southern California Edison Home Energy Reports Program Impacts (Final Report)
			SDG&E Home Energy Reports Program 2013 Impact Evaluation ED Res 3.3
			Impact Evaluation of 2014 San Diego Gas & Electric Home Energy Reports Program (Final Report)
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
			Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
	ESPI Ex-Post Deemed	CFL	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final

		Computer Power Mgt	2014 Nonresidential Downstream Deemed Plug Load PC Power Management Software ESPI Impact Evaluation Report
		De-lamping	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
		Home Energy Reports	2013 PG&E Home Energy Reports Program Review and Validation of Impact Evaluation ED Res 3.1
			Review and Validation of 2014 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
		Home Energy Surveys	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
			Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
		Home Energy Upgrade	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
			Focused Impact Evaluation of the 2013-2014 Home Upgrade Program
		HVAC Mini	Net-to-gross Evaluation of 2013-14 Upstream HVAC Programs (HVAC 1)
		HVAC Quality	Net-to-gross Evaluation of 2013-14 Commercial Quality Maintenance Programs (HVAC3)
		LED	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
		LED Nightlights	Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
		Occupancy	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
			2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
		Pipe Insulation	2013 Nonresidential Downstream Deemed ESPI Net-to-Gross Evaluation For Sprinkler and Pipe Insulation Measures
			2014 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report
		Pool Pumps	Impact Evaluation of 2013-2014 SDG&E Residential VSD Pool Pump Program

		Sprinklers	2013 Nonresidential Downstream Deemed ESPI Net-to-Gross Evaluation For Sprinkler and Pipe Insulation Measures
			2014 Nonresidential Downstream Deemed ESPI Low-Pressure Sprinkler Nozzle Impact Evaluation Report
		T5 Linear Fluorescents	2013 Nonresidential Downstream Deemed Lighting Impact Evaluation Report
			2014 Nonresidential Downstream Deemed ESPI Lighting Impact Evaluation Report
			Impact Evaluation of 2013-14 Upstream and Residential Downstream Lighting Programs
		Water Kits	2013-2014 Residential Roadmap Multifamily Focused Impact Evaluation - Final
2015	ESPI Ex-Post Custom	NA	2015 Nonresidential ESPI Custom Lighting Impact Evaluation
			Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)
			2015 Custom Impact Evaluation Industrial, Agriculture and Large Commercial
			Review and Validation of 2015 Southern California Edison Home Energy Reports Program Impacts (Final Report)
			Impact Evaluation of 2015 San Diego Gas & Electric Home Energy Reports Program (Final Report)
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
			2015 Single-family Home Energy Upgrade Impact Evaluation*
	ESPI Ex-Post Deemed	CFL > 30W	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2015 Upstream and Residential Downstream Lighting Programs
		De-lamping	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
		Home Energy Reports	Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts (Final Report)
		Home Energy Survey	2015 SCE HEES Impact Evaluation
		Home Energy Upgrade	2015 Single-family Home Energy Upgrade Impact Evaluation*
		HVAC Mini	Impact Evaluation of 2015 Upstream HVAC Programs (HVAC 1)
		HVAC Quality	Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		LED	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2015 Upstream and Residential Downstream Lighting Programs
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		LED	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation

		Outdoor	2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		LED Streetlights	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
		Occupancy Sensors	2015 Nonresidential ESPI Deemed Lighting Impact Evaluation
			2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report
		Pipe Insulation	2015 Nonresidential Downstream ESPI Deemed Pipe Insulation Impact Evaluation
		Pool Covers	2015 Nonresidential Downstream ESPI Deemed Pool Cover Impact Evaluation
		Sprinklers	2015 Nonresidential Downstream ESPI Deemed Sprinkler Impact Evaluation
		Water Kits	2013-2015 Residential Roadmap 2015 Multifamily Focused Impact Evaluation Report

In contrast to prior program cycles, evaluation results for the 13-15 cycle were provided by the impact evaluation leads in a similar format to that provided by the PAs. First, the claims data for each program year was partitioned into separate impact evaluation reports. Next, impact evaluation teams were responsible for providing claim level results to the data processing team using a standardized template. The data processing team performed many quality checks, however, in addition, the standardized data template was used for automated generation of the Impact Evaluation Standardized Reporting (IESR) appendices printed in each impact evaluation report. These appendix tables served as a quality check for the impact evaluation teams. This information is used to generate the ex-post dataset.

Following standardized claim level results reporting there is one final step in evaluation data reporting. This final step covers submission of all raw and processed evaluation data, analysis and processing code, and field tracking data to the online Energy Division data library. The data library is maintained by Energy Division for future reference for evaluation activities and for savings estimation analysis (i.e. ex ante values for work papers or DEER updates).

Creation of Ex-Post Dataset

The payments from the ESPI mechanism are driven by a combined 2013-2015 ex post dataset. This dataset contains both ex ante and ex post savings values as well as all parameters necessary for their calculations. The basis of the ex post dataset are the quarterly tracking data claims (described in detail in Appendix G). Once the claims have been submitted by the PAs to the CPUC, and passed all quality control checks, they form the ex ante portion of the ex post database. The ex post portion of the dataset is provided by the previously mentioned ex post evaluations. These ESPI impact evaluation reports, overseen by the CPUC, were performed on custom measures and specific deemed measures with uncertain ex ante parameter values.

Each ex ante claim submitted throughout 2013-2015 was assigned to an individual impact evaluation report where appropriate. Each claims subject to ex post evaluation was assigned to exactly one evaluation report. Then an impact evaluation specific database was generated and posted to Energy Division Central Server (EDCS) Smartfile for each evaluation teams to fill out claim level evaluation results. These databases were filled out by evaluators, and posted in return on EDCS Smartfile. All databases complete with ex post results,

were then downloaded and run through iterative and through quality control checks to verify consistent and accurate results. All impact evaluation specific databases are combined with each other and those claims not subject to ex post evaluation to create a final ex post database.

Each claim was identified as either being available for ex post evaluation or not. The following decision tree shows how ED staff determined the situations in which a claim was classified.

Appendix I: Order-Independent Impacts of Ex Post Parameter updates on Ex Ante Reported Parameters.

The following graphs demonstrate the quantitative impact of updating ex-ante reported impact parameters to ex-post evaluated impact parameters. These "waterfall" figures show both gross and net savings, and illustrate quantitative drivers behind ex ante and ex post discrepancies. In past evaluations, such information had often been reported with tabular data, equations, and contextual narrative. Furthermore, past impact evaluations would assess ex ante versus ex post differences at the gross level, then estimate ex post net-to-gross ratios, and finally provide a net savings estimate. In this evaluation cycle, a new methodology was developed[167] such that steps are order-independent and for two of three domains: gross and net. (The hybrid domain, described in the whitepaper, was not used in this appendix.)

This new methodology created an order–independent graphical representation of the impacts of ex post updates by combining parameters, which ensures that the impacts represented do not depend on the order in which the ex-post evaluated parameters update and replace ex-ante reported parameters. Combining parameters for individual waterfall steps results in each step of the waterfall representing the quantitative impact of updating multiple ex-ante parameters to ex-post parameters, rather than just an individual parameter.

The gross waterfall graphics show the impact of parameter updates on gross savings and the combined effect of the NTGR. Because many evaluation stakeholders (e.g. regulators, policymakers, and ratepayers) are better served by an understanding of savings and adjustments on a net basis, the net waterfall first translates from gross to net and then shows the impact of parameter updates on net savings.

For detailed information on this parameter update methodology, please refer to the white paper "Development of Order-Independent Waterfall Graphics to Enable Comprehensive Understanding of Impact Evaluation Results."

[167] "Development of Order-Independent Waterfall Graphics to Enable Comprehensive Understanding of Impact Evaluation Results." 2017. Adam M. Scheer and Robert Kasman (PG&E) James Gilll (Itron Consulting.) https://pda.energydataweb.com/#/documents/1958/view

Figure I-1a: Statewide Evaluated Gross Waterfall First Year - Electric (GWh)

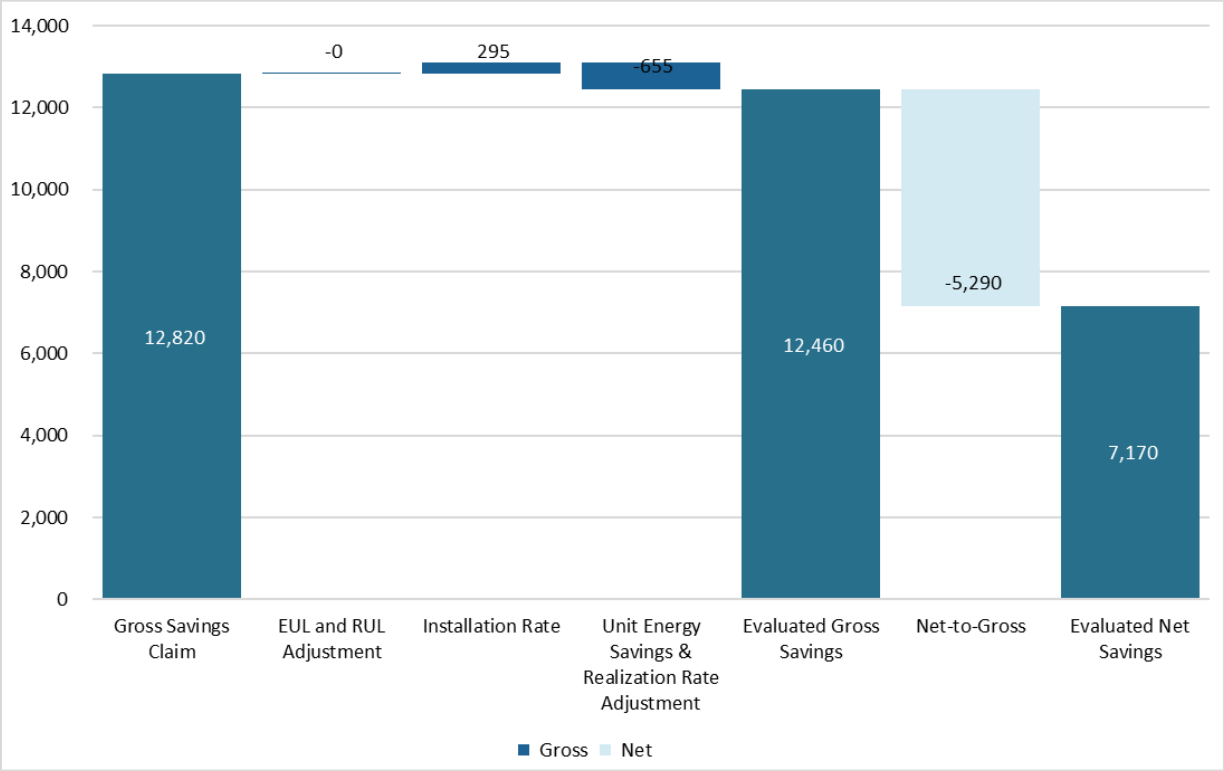


Figure I-1b: Statewide Evaluated Net Waterfall First Year - Electric (GWh)

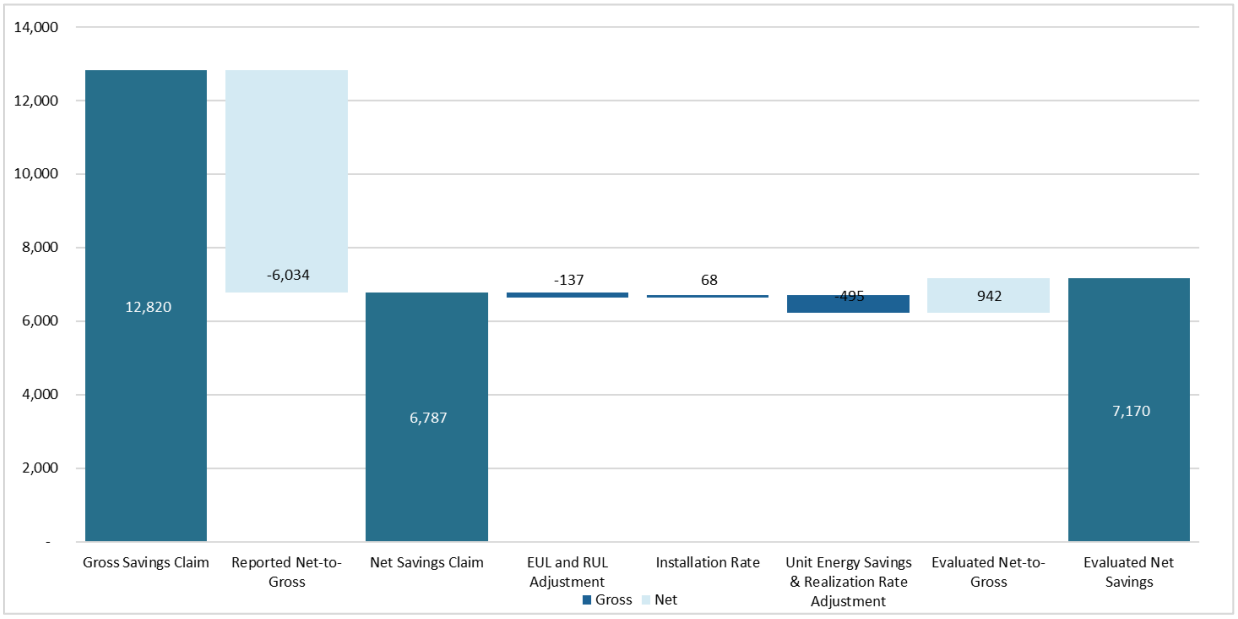


Figure I-2a: Statewide Evaluated Gross Waterfall Lifecycle - Electric (GWh)

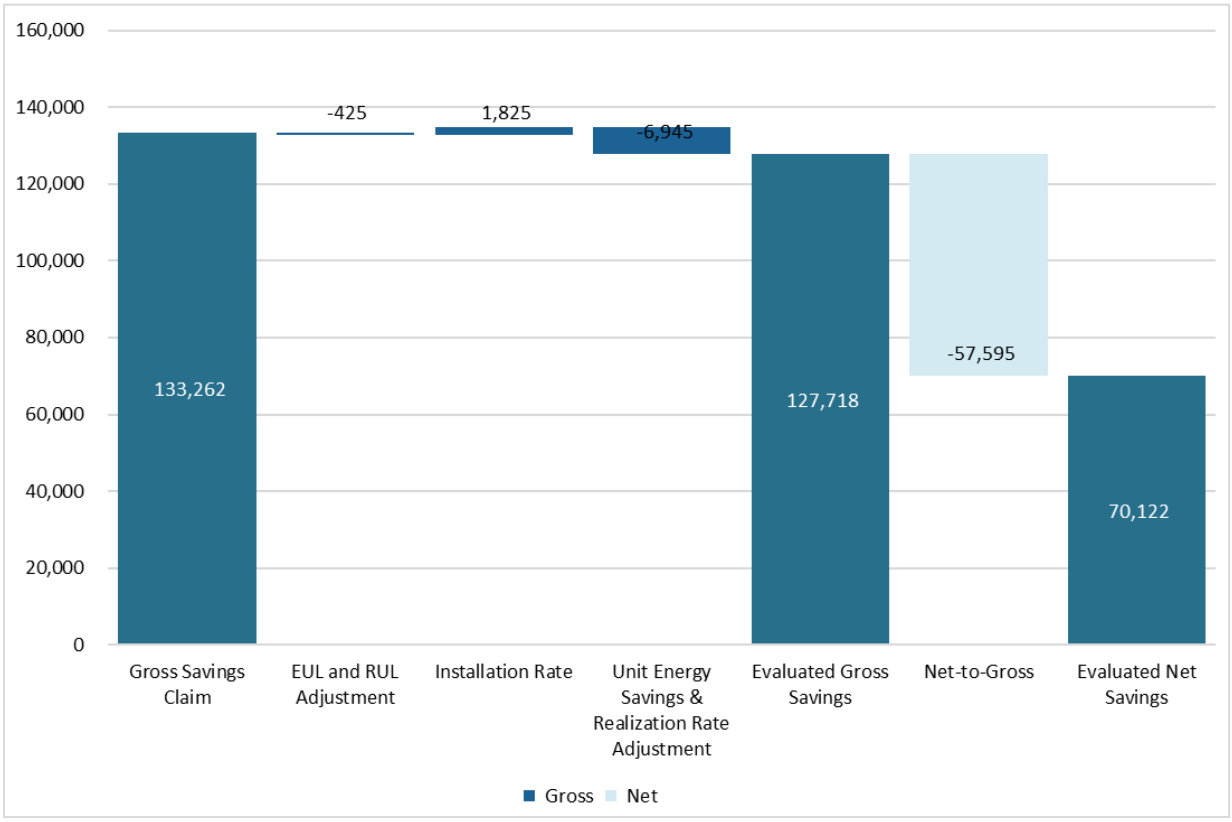


Figure I-2b: Statewide Evaluated Net Waterfall Lifecycle - Electric (GWh)

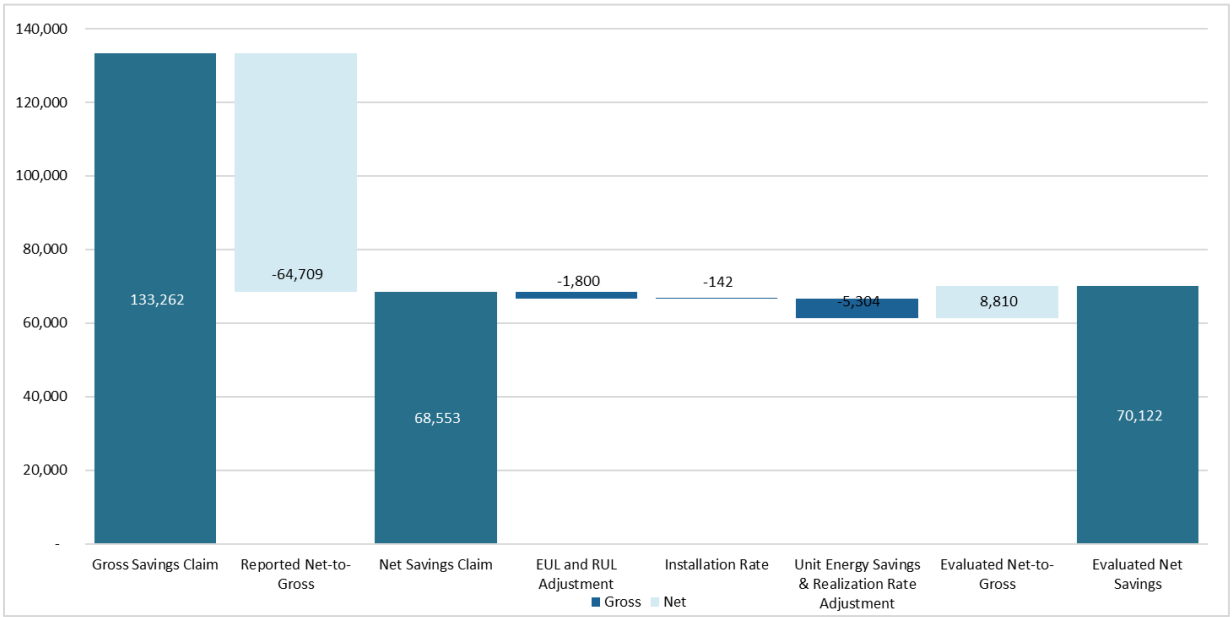


Figure I-3a: PGE Evaluated Gross Waterfall First Year - Electric (GWh)

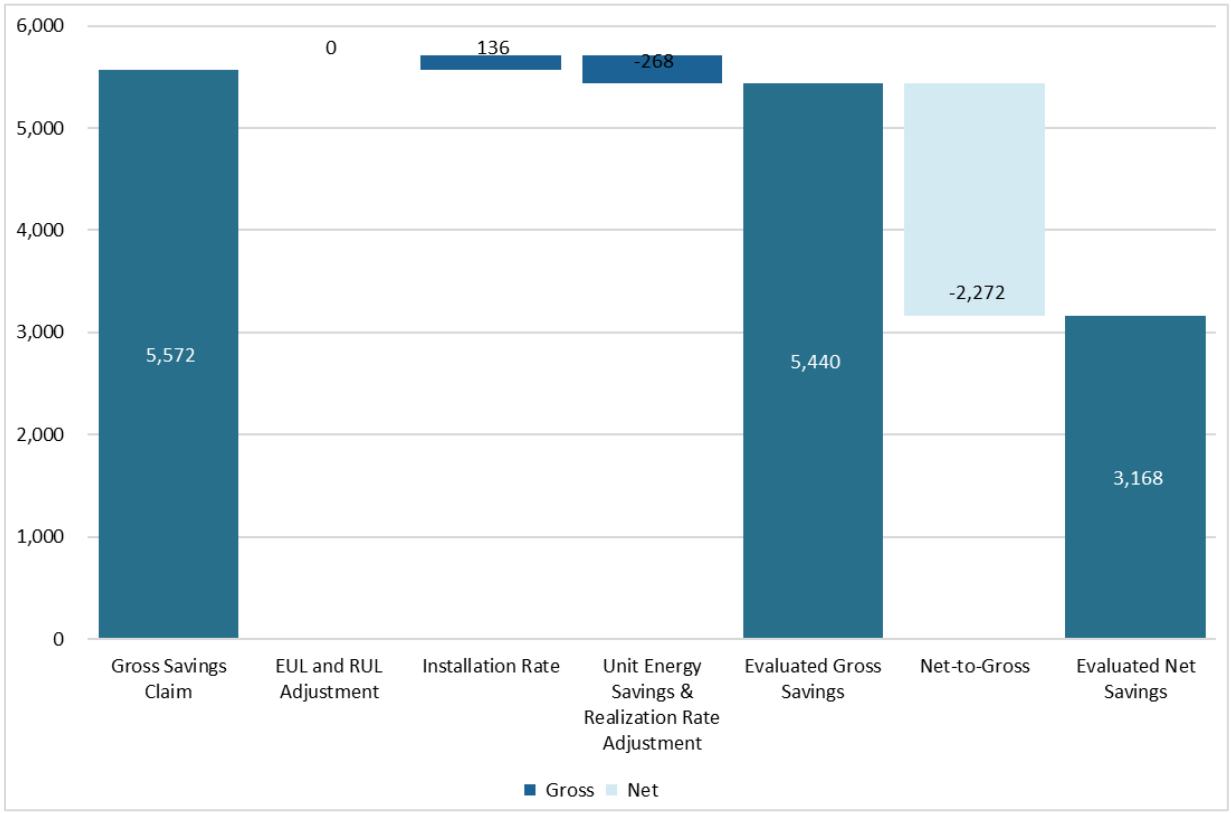


Figure I-3b: PGE Evaluated Net Waterfall First Year - Electric (GWh)

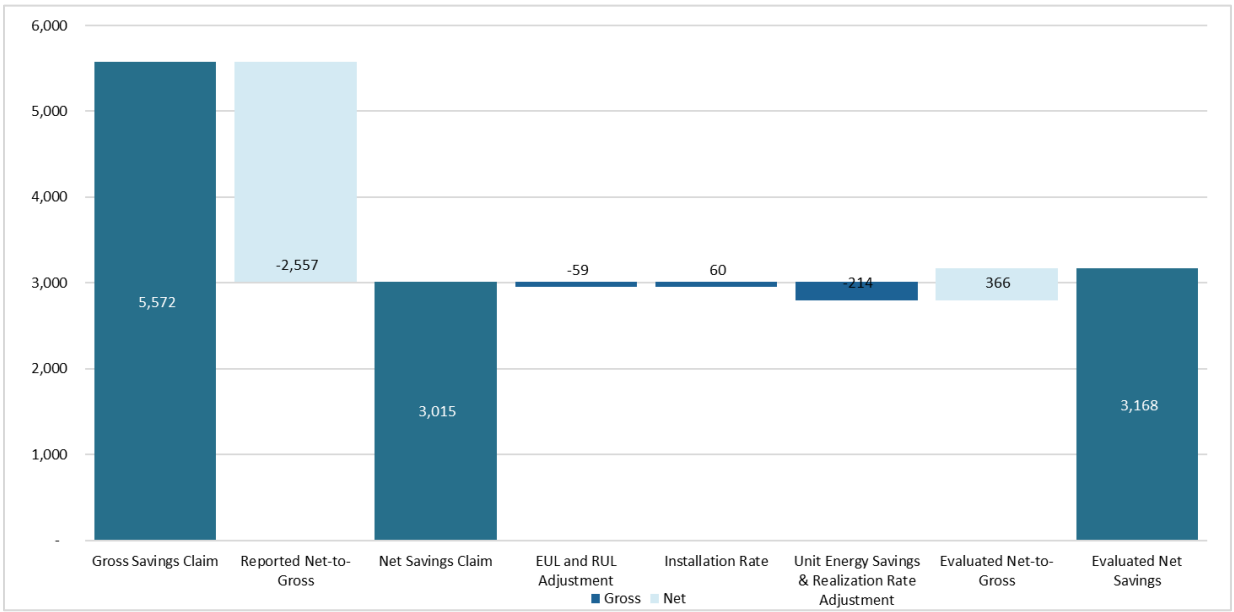


Figure I-4a: PGE Evaluated Gross Waterfall Lifecycle - Electric (GWh)

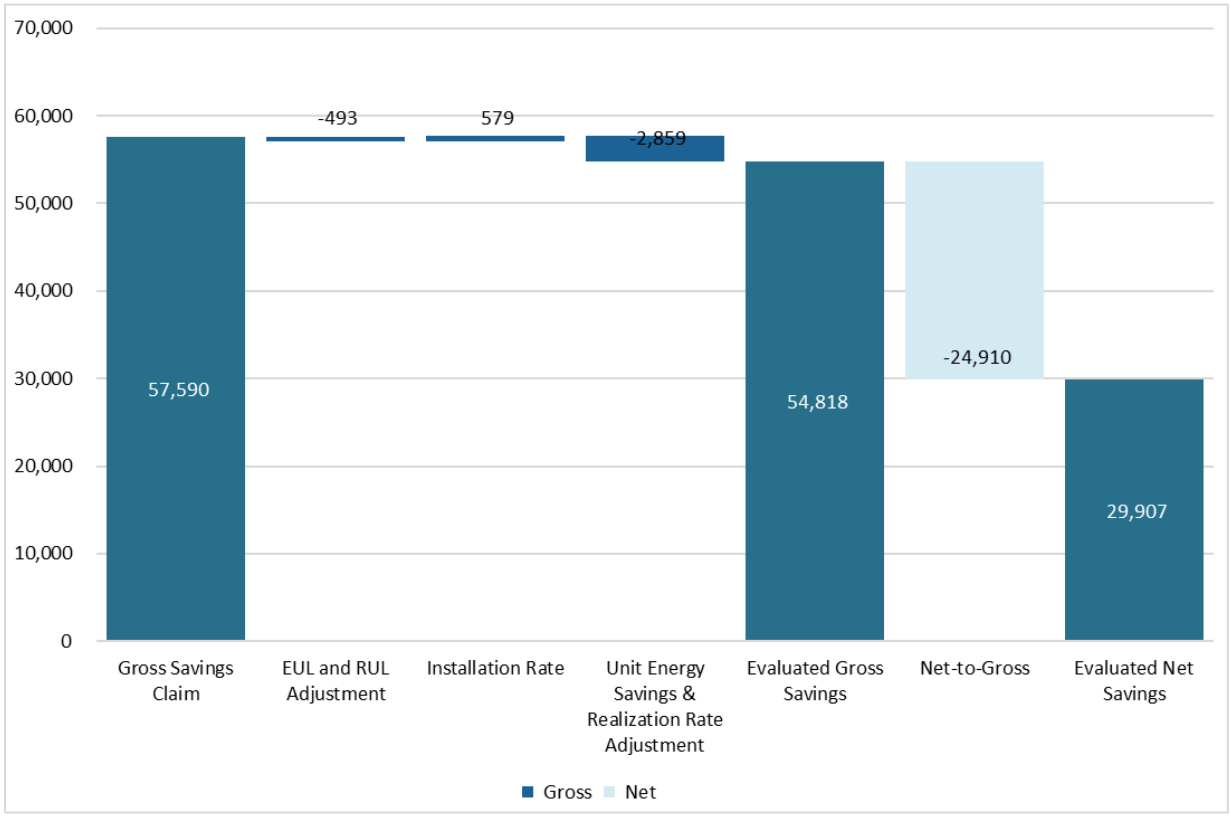


Figure I-4b: PGE Evaluated Net Waterfall Lifecycle - Electric (GWh)

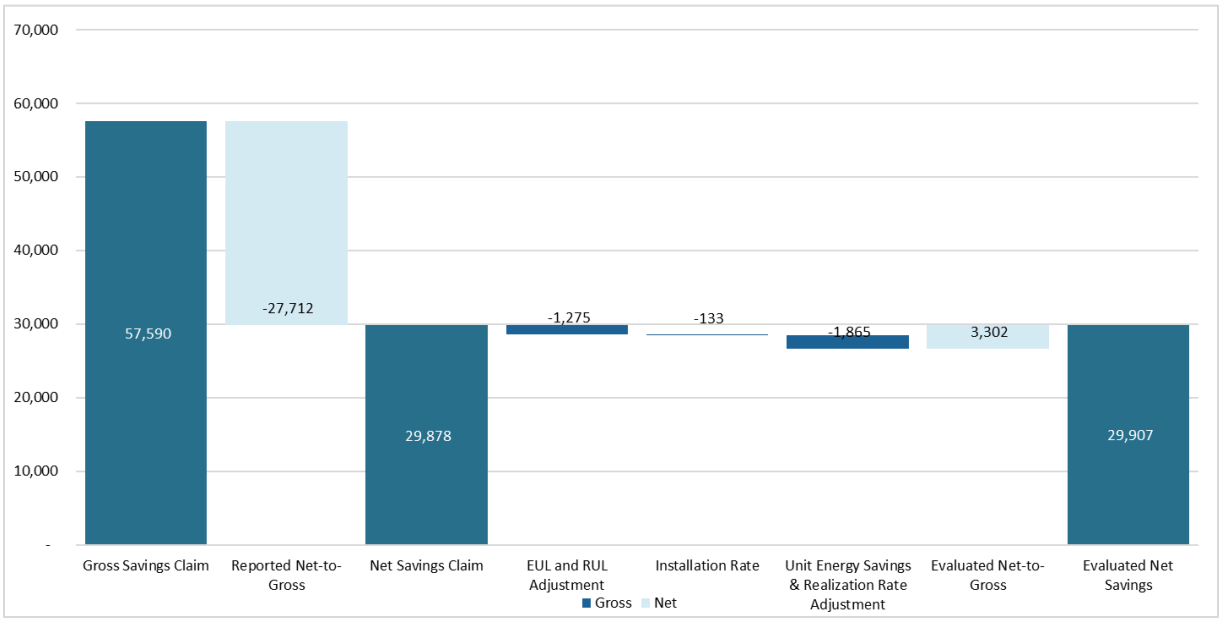


Figure I-5a: SCE Evaluated Gross Waterfall First Year - Electric (GWh)

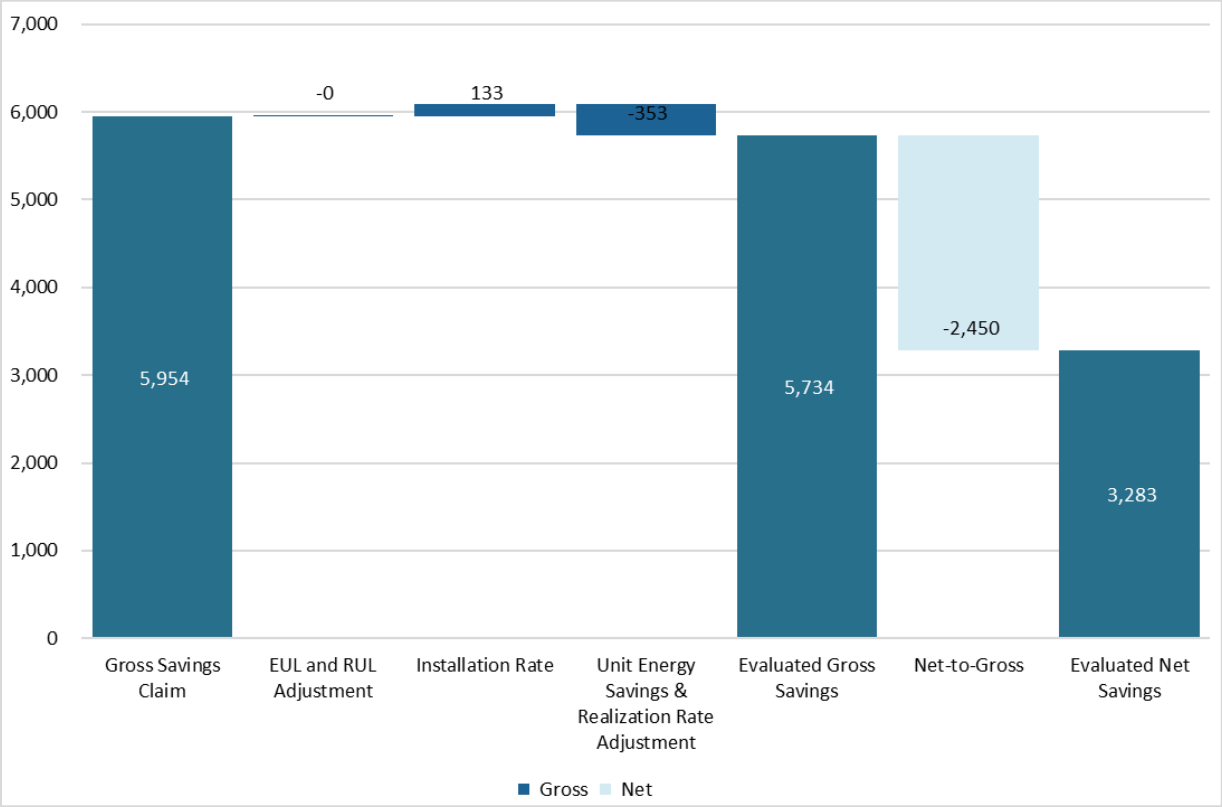


Figure I-5b: SCE Evaluated Net Waterfall First Year - Electric (GWh)

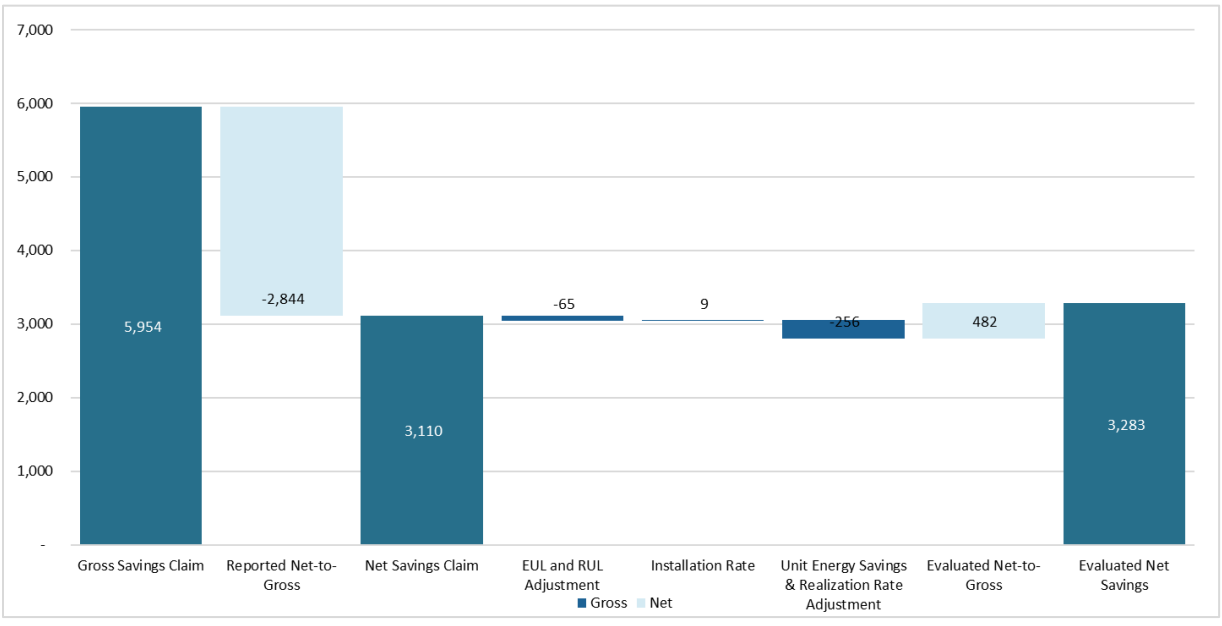


Figure I-6a: SCE Evaluated Gross Waterfall Lifecycle - Electric (GWh)

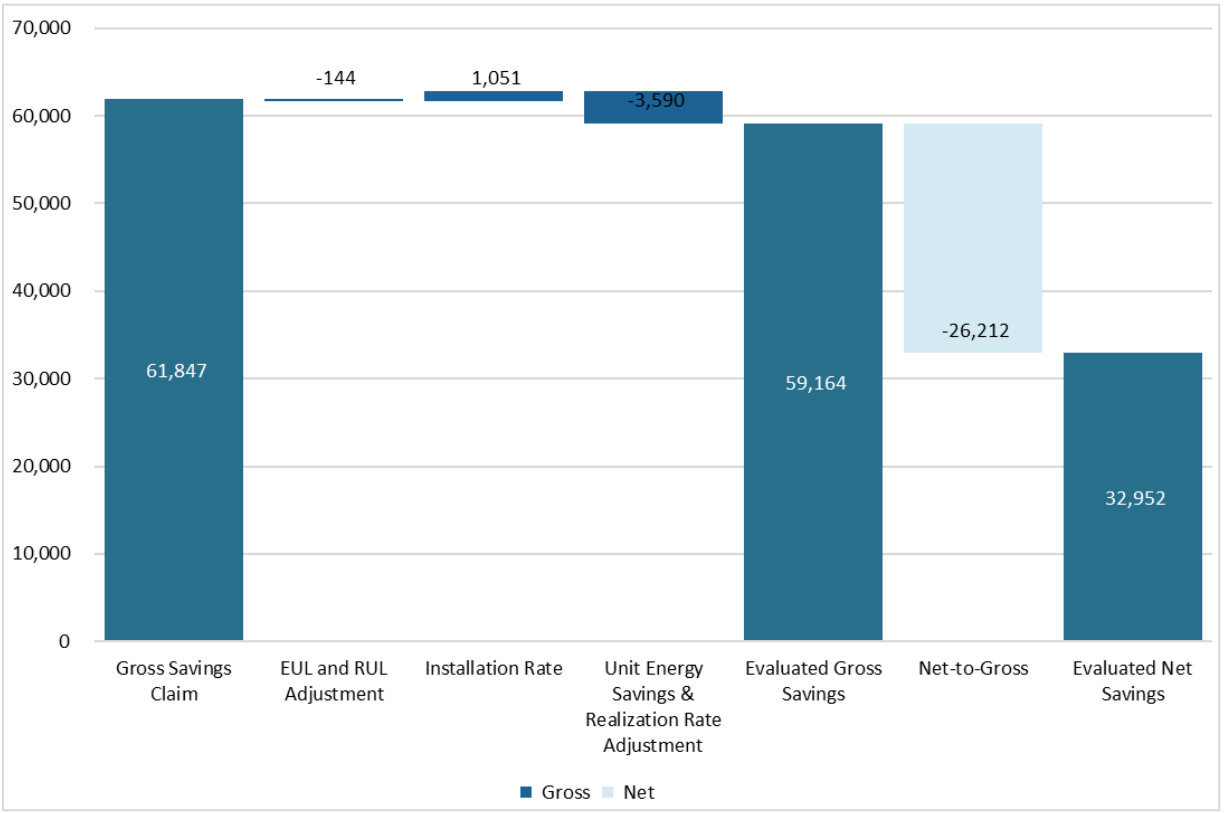


Figure I-6b: SCE Evaluated Net Waterfall Lifecycle - Electric (GWh)

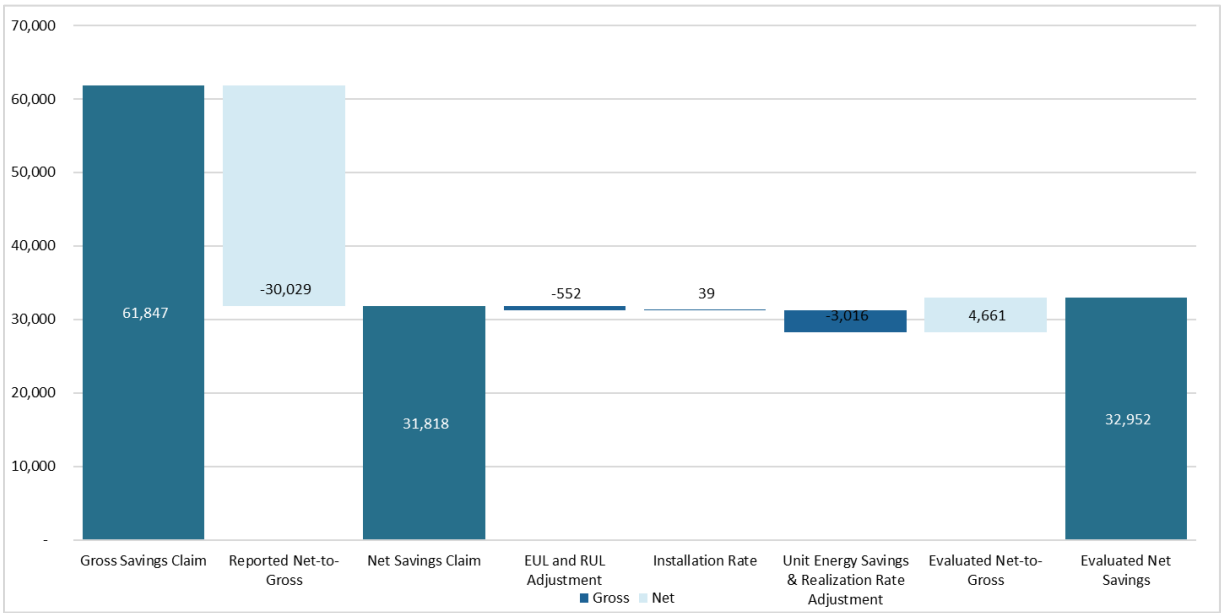


Figure I-7a: SCG Evaluated Gross Waterfall First Year - Natural Gas (MMTherms)

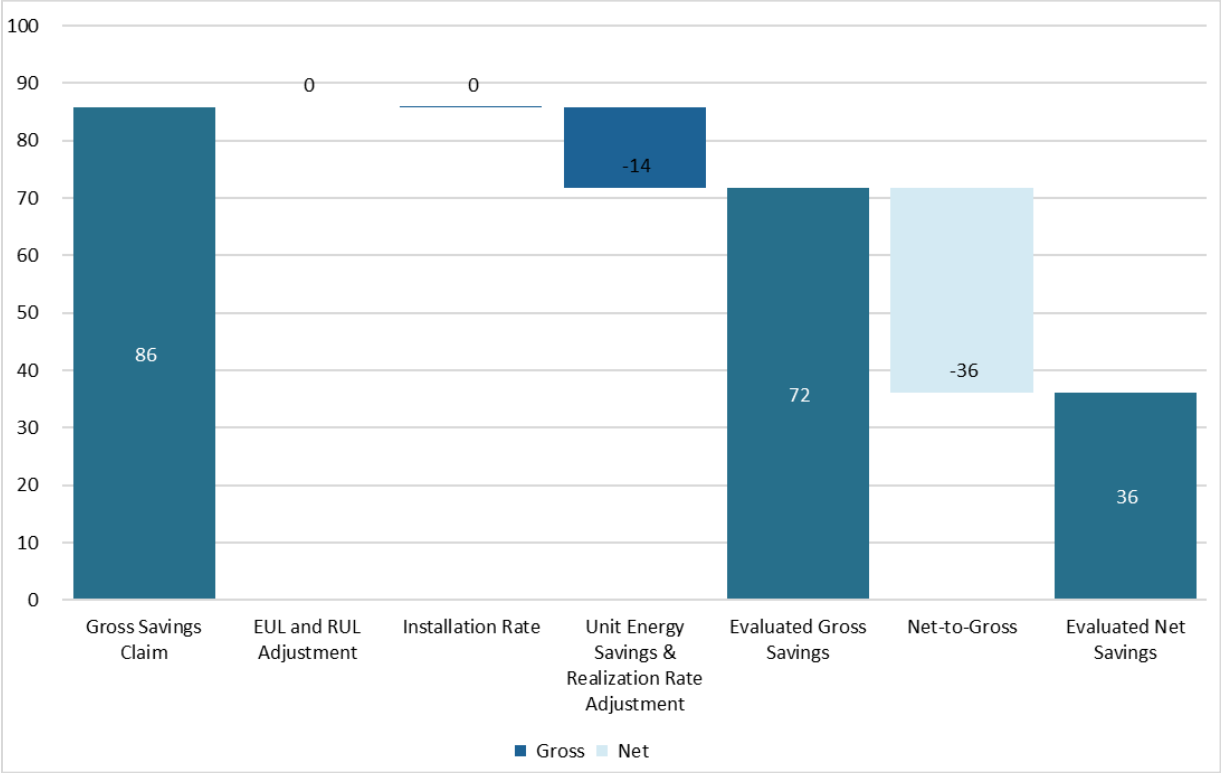


Figure I-7b: SCG Evaluated Net Waterfall First Year - Natural Gas (MMTherms)

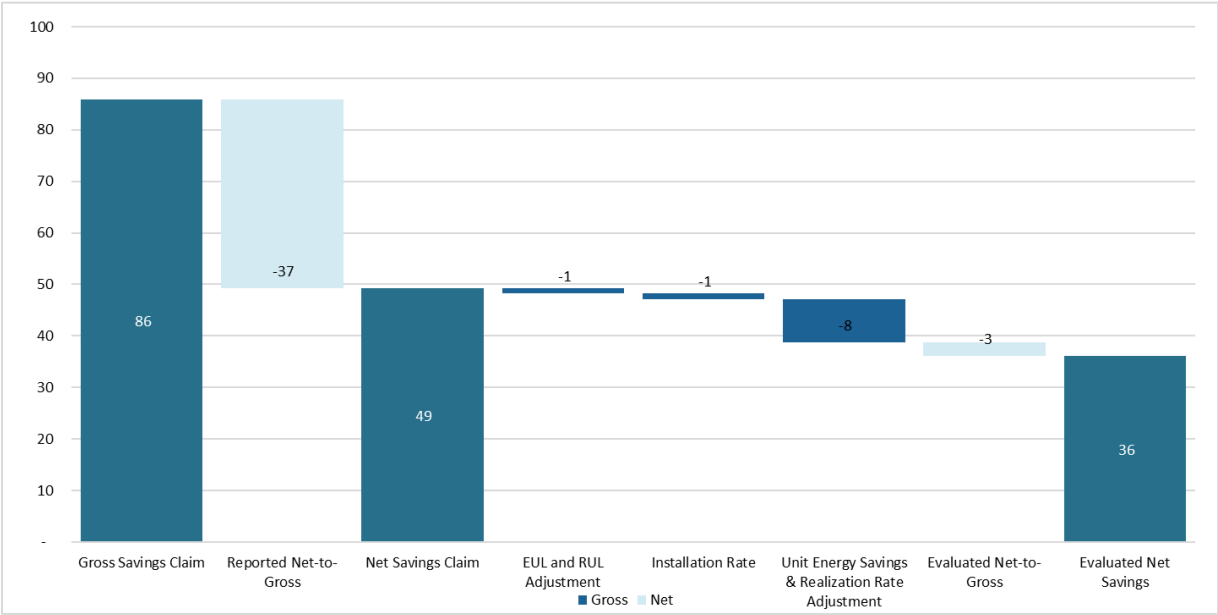


Figure I-8a: SCG Evaluated Gross Waterfall Lifecycle - Natural Gas (MMTherms)

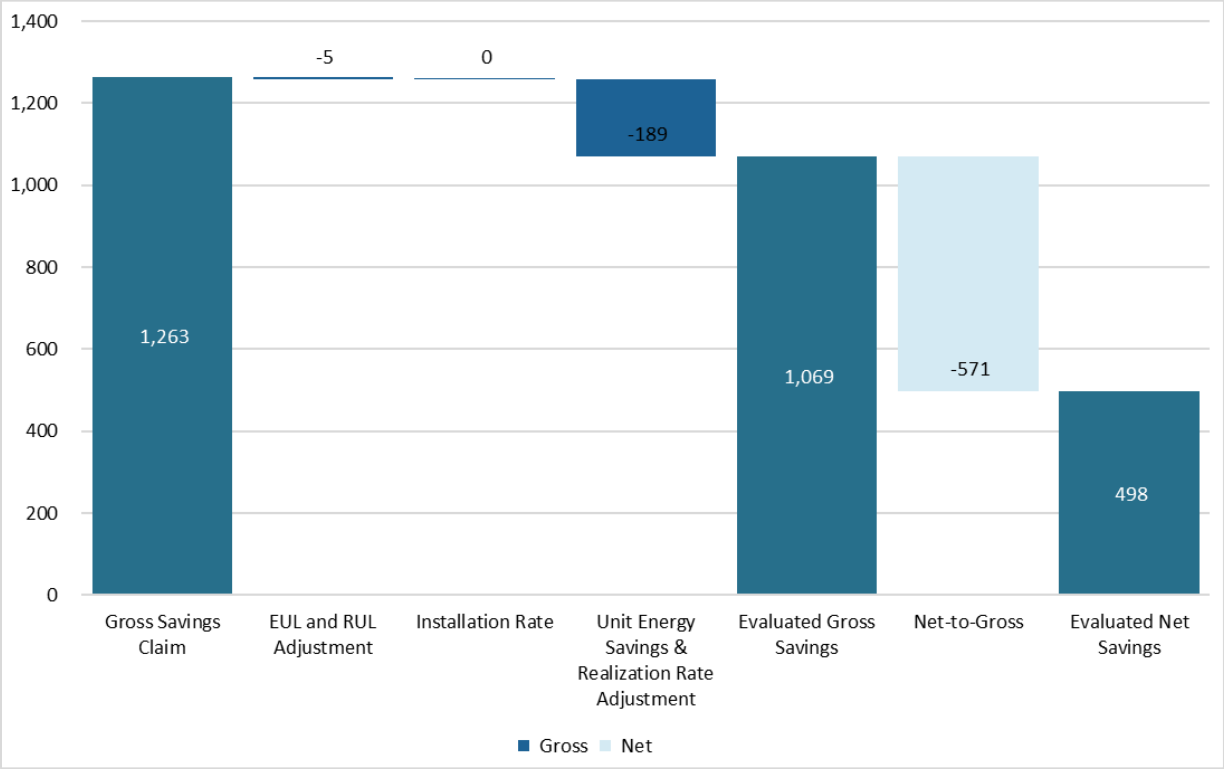


Figure I-8b: SCG Evaluated Net Waterfall Lifecycle - Natural Gas (MMTherms)

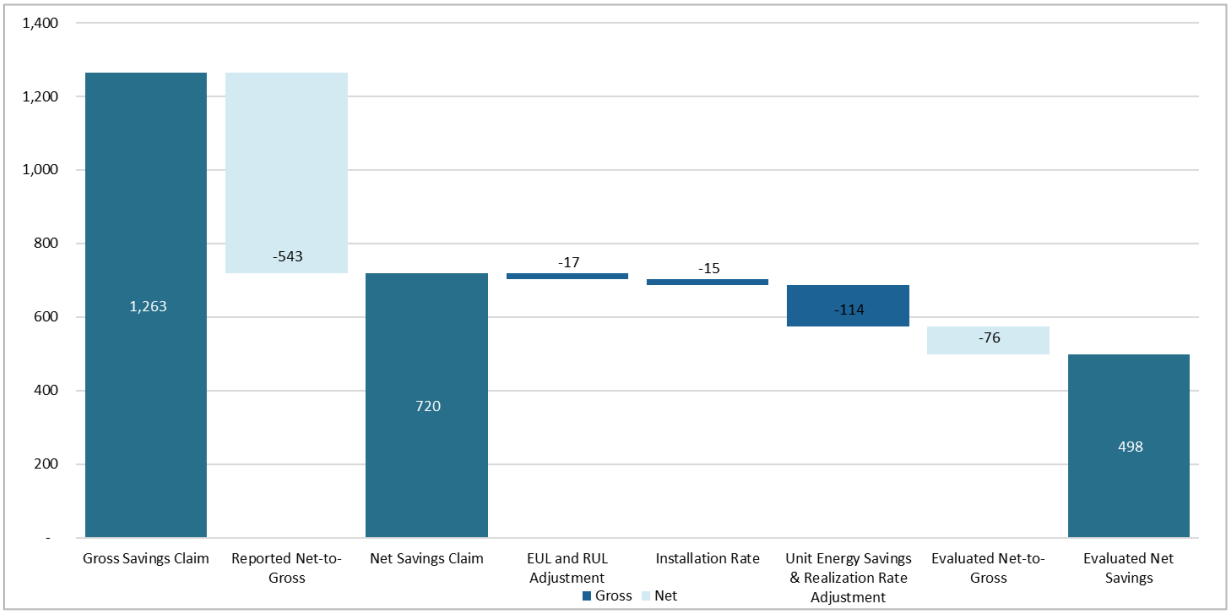


Figure I-9a: SDGE Evaluated Gross Waterfall First Year - Electric (GWh)

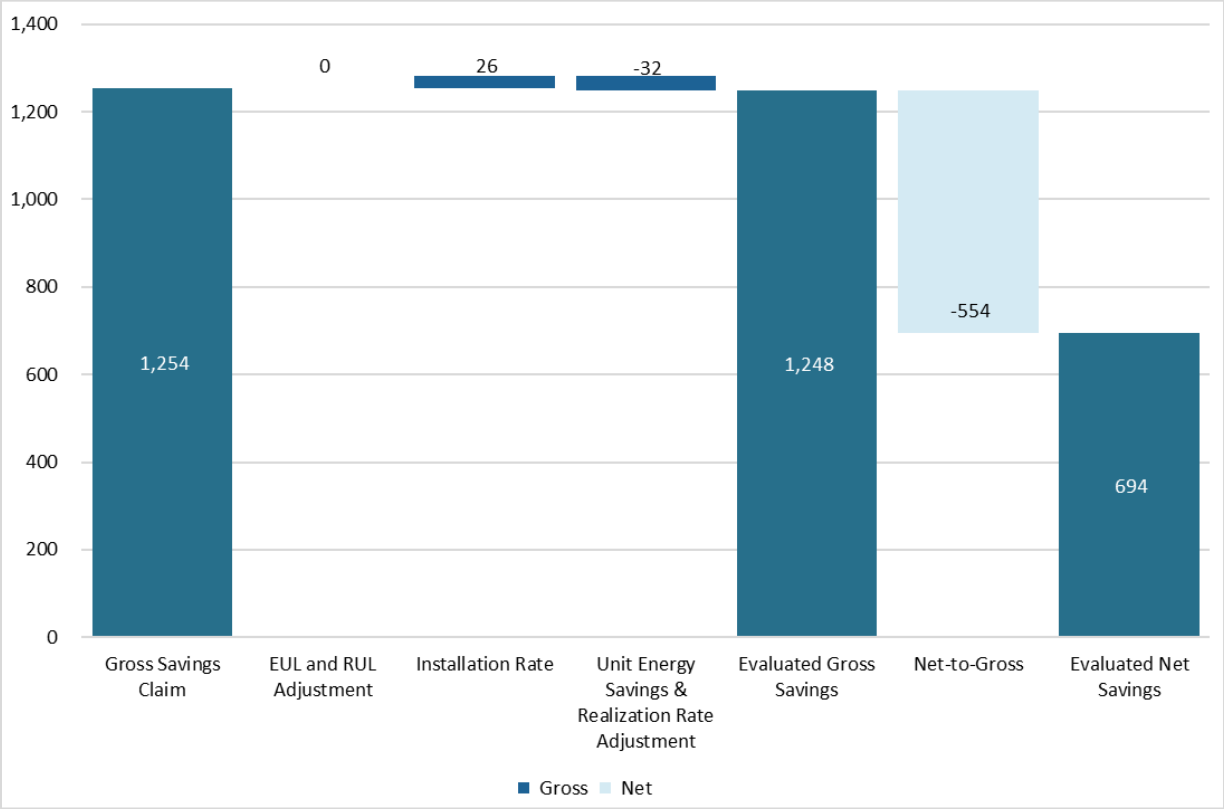


Figure I-9b: SDGE Evaluated Net Waterfall First Year - Electric (GWh)

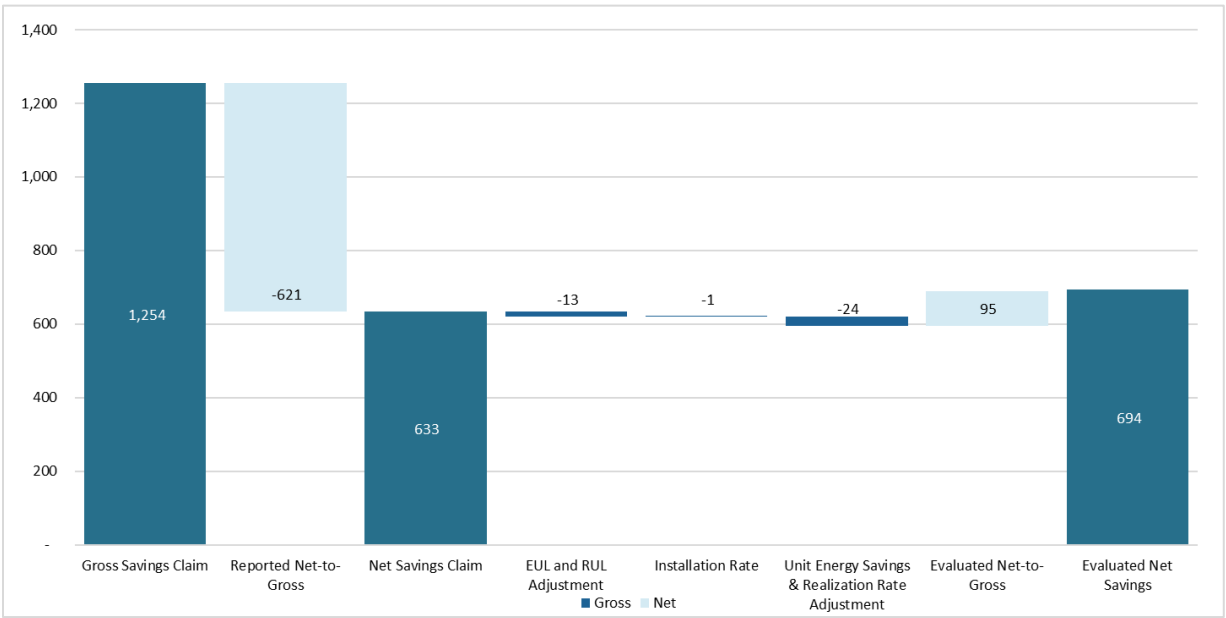


Figure I-10a: SDGE Evaluated Gross Waterfall Lifecycle - Electric (GWh)

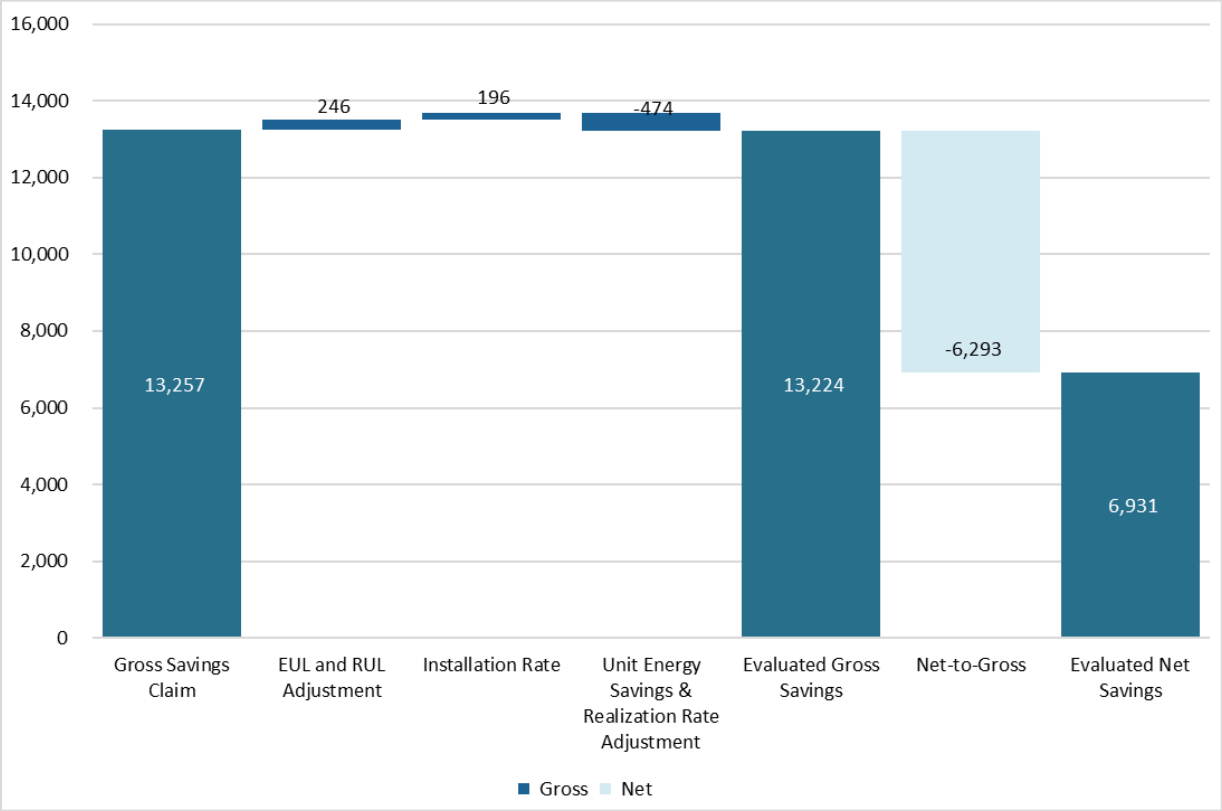
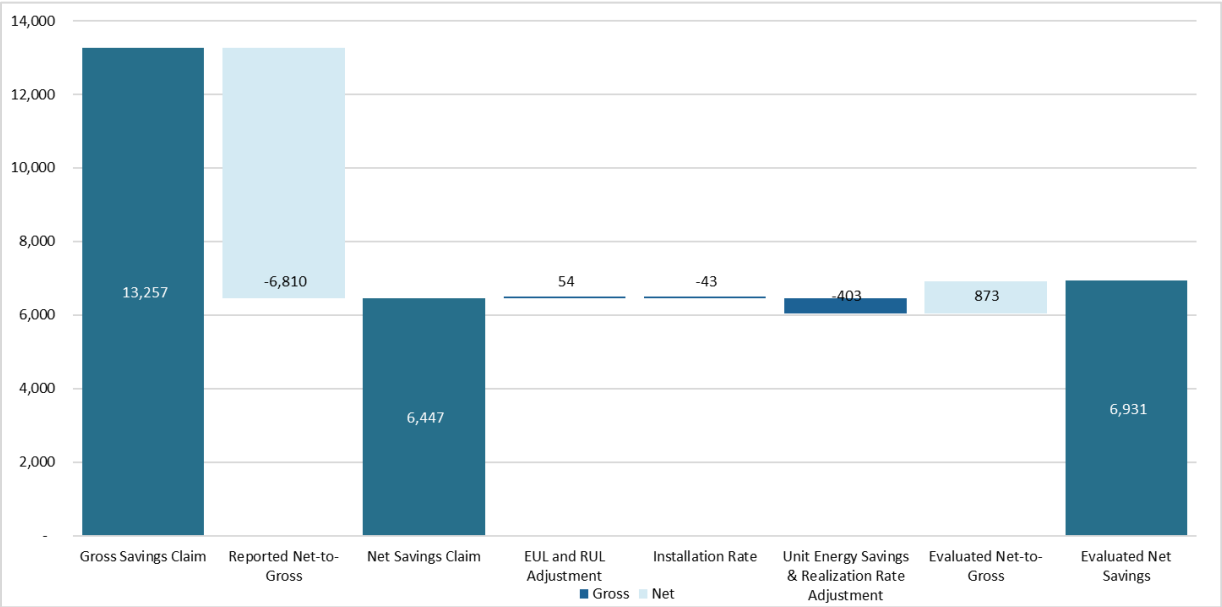


Figure I-10b: SDGE Evaluated Net Waterfall Lifecycle - Electric (GWh)



Appendix J: Chapter Data Overlaps

An excel file containing the data used in this appendix is available.

The 2013-2015 Evaluation Report chapters present findings from the 2013-2015 energy efficiency evaluation studies by sector -- residential, commercial, industrial and agricultural – but also by end uses such as lighting and HVAC, which provide substantial savings across market sectors. This appendix provides an explanation of the relative impacts of these end uses on each market sector.

Table J-1: Savings Impacts of Lighting and HVAC Measures on Market Sectors

Chapter Sector	Chapter End Use	First Year Gross MW	Lifecycle Gross GWhEval	Lifecycle Gross MMThEval
Residential	HVAC	61.1	721.9	20.4
Residential	Lighting	135.1	12476.6	-229.8
Other	Other	0.0	0.0	0.0
Residential	Other	850.2	34116.7	379.7
Commercial	Lighting	271.0	13750.1	-36.3
Commercial	Other	878.9	53357.0	907.7
Commercial	HVAC	97.1	5968.4	121.3
Industrial & Ag	Lighting	18.7	1274.2	-1.4
Industrial & Ag	Other	77.1	5096.9	519.4
Industrial & Ag	HVAC	18.4	955.7	25.5

Figure J-1: Residential Chapter Lifecycle Gross Evaluated Electricity Savings by End Use Chapters

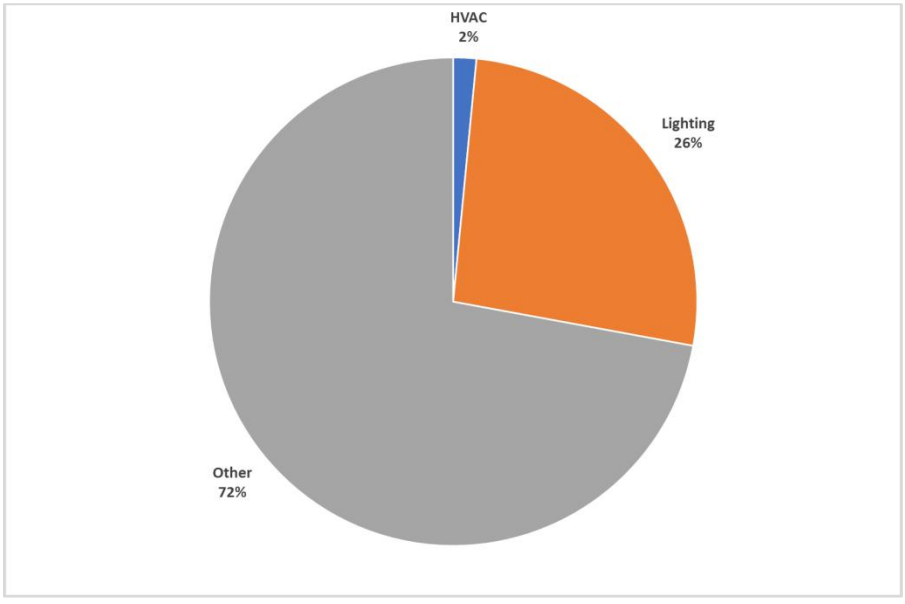


Figure J-2: Commercial Chapter Lifecycle Gross Evaluated Electricity Savings by End Use Chapters

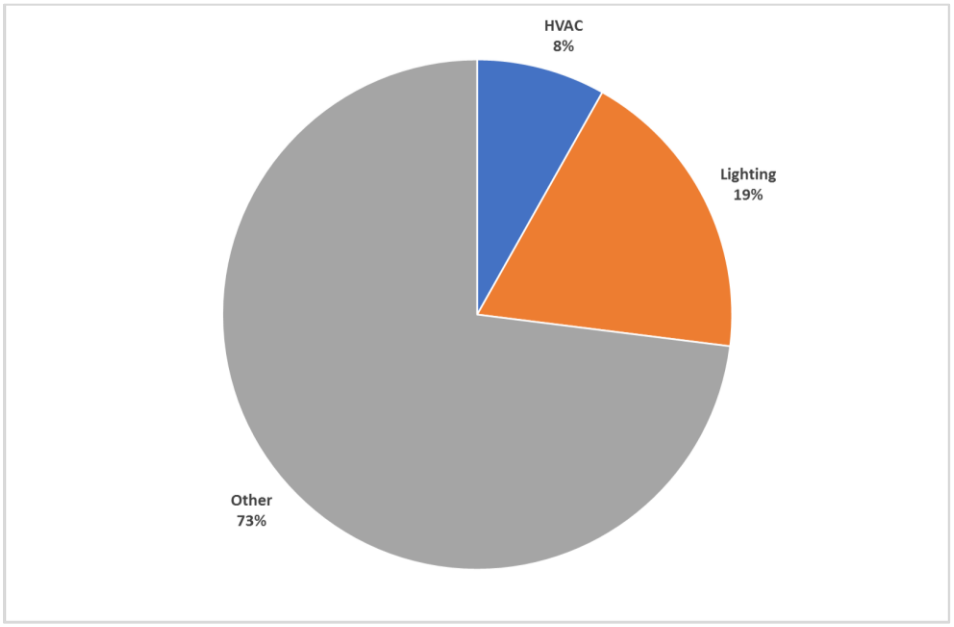


Figure J-3: Industrial & Agriculture Chapter Lifecycle Gross Evaluated Electricity Savings by End Use Chapters

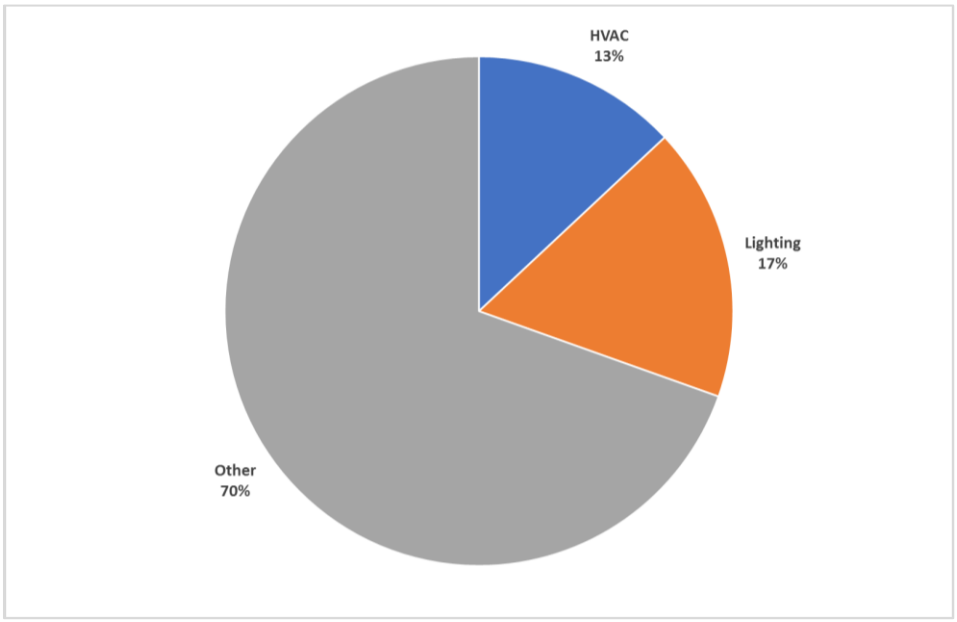


Figure J-4: Lighting Chapter Lifecycle Gross Evaluated Electricity Savings by Market Sector Chapters

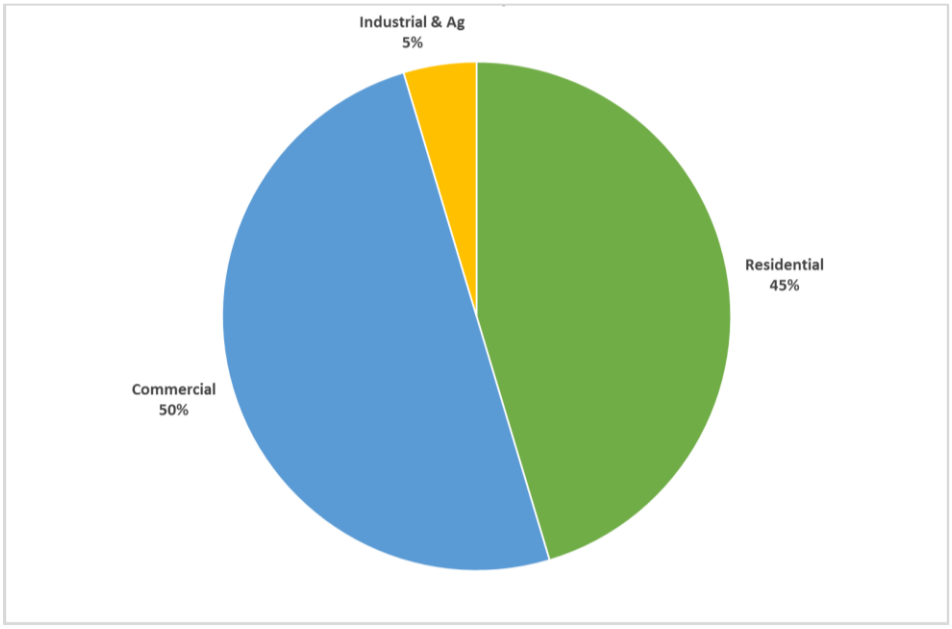


Figure J-5: HVAC Chapter Lifecycle Gross Evaluated Electricity Savings by Market Sector Chapters