



# 2006-2008 Energy Efficiency Evaluation Report

## Executive Summary



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Prepared by Energy Division





## **Acknowledgments**

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## EXECUTIVE SUMMARY

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### ES 1. Introduction

Energy Division presents in this report the accomplishments of California's four largest Investor Owned Utilities' (IOUs) [Pacific Gas & Electric (PGE), Southern California Edison (SCE), San Diego Gas & Electric (SDGE) and Southern California Gas (SCG)] energy efficiency program activities for the 2006 - 2008 program cycle. The IOUs implemented energy efficiency programs, either directly or through third parties, designed to improve energy efficiency in multiple market sectors, including residential, commercial, industrial and agricultural, via monetary incentives and other program interventions.

The California Public Utilities Commission directed its Energy Division to evaluate the programs and verify the resulting energy savings and demand reductions. The aggregate results of the evaluation are the subject of this report. Energy Division directed these studies, which were implemented by leading evaluation professionals and subject to an extensive public review process. The 2006-2008 evaluation is the first time the IOUs' portfolios of energy efficiency programs were evaluated using consistent methods laid out in the California Energy Efficiency Evaluation Protocols and the first time consistent data sets were compiled across IOUs at the technology or measure<sup>1</sup> level. This was accomplished with the cooperation and significant contributions of the IOUs and enables aggregation of savings and other parameters across IOUs, technologies, and programs.

This report includes the findings and recommendations from the 2006-2008 evaluation studies that began in September 2007 and were finalized in February 2010. The results of the evaluation studies form the foundation for systematic updates to the utility-reported savings assumptions used to estimate portfolio and program savings and cost effectiveness, and also provide critical information for programmatic improvements and future savings estimates. This report marks the conclusion of the evaluations conducted for the 2006-2008 program cycle and presents the evaluated estimate of the savings achieved by the IOU portfolios.

Evaluated savings estimates were developed from measurements taken after the efficiency measures were installed. Consequently, the evaluated savings reflect the conditions observed in the field during or shortly after program completion and data analysis for representative samples of program participants. The savings estimates presented in this report differ from the savings estimates reported by the utilities,<sup>2</sup> which are based on assumptions developed prior to the implementation of the 2006-2008 program cycle.

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<sup>1</sup> The term "measures" captures both the installation of specific technologies and other program interventions that lead to improvements in energy efficiency.

<sup>2</sup> Utility-reported savings estimates are posted on the Commission's Energy Efficiency Groupware Application (EEGA) website [www.eega2006.cpuc.ca.gov](http://www.eega2006.cpuc.ca.gov).

## ES 2. Impact of California Ratepayer Energy Efficiency Investments in 2006-2008

### ES 2.1. Energy Savings and Emissions Reductions

California's \$2.1 billion IOU ratepayer investment in energy efficiency for the 2006 – 2008 program cycle resulted in over 6,000 GWh, 80 million therms, and over 1,100 MW in annual energy savings for program participants over the three-year program cycle. Approximately two-thirds of those savings would not have occurred without program intervention. Over the life of the measures installed by program participants, the savings are estimated to be over 66,000 GWh and over 1,000 million therms. The savings presented here and in the remainder of this report represent savings that were confirmed through field evaluation work to verify that the energy efficient technologies were installed and are producing savings, and that they represent the savings directly attributable to the program intervention. As a point of comparison, the energy savings by the end of 2008 represent approximately 3.2% of electricity and 1.0% of the natural gas sold in that year.<sup>3</sup> The energy savings impacts also resulted in over 4 million tons of avoided CO<sub>2</sub> emissions; the equivalent of 760,456 cars being removed from California's roads.<sup>4</sup>

**Table 1. Savings Impacts from 2006-2008 IOU Energy Efficiency Investments<sup>5</sup>**

	Annual Impact		Lifecycle Impact		% of 2008 IOU sales Gross
	Gross	Net	Gross	Net	
<b>GWh</b>	6,497	4,097	66,142	42,736	3.2%
<b>MW</b>	1,175	779			
<b>MMTherm</b>	84	44	1,379	690	1.0%
<b>Tons of CO<sub>2</sub></b>	4,116,173	2,642,128	45,021,664	24,291,576	

Over the three-year cycle the energy efficiency actions in California, including education and training efforts, resulted in:

- 64 million compact fluorescent light bulbs installed and in operation;
- 41 million square feet of installed insulation;
- 1.2 million new energy efficient household appliances;
- 775 MWh in savings from improved manufacturing processes;

<sup>3</sup> Total electric and gas sales for the four IOUs for 2006-2008 were approximately 591,000 GWh and 32.5 billion therms. Sales data taken from the IOUs' FERC I and II reports for 2006-2008 on file at the CPUC.

<sup>4</sup> In estimating CO<sub>2</sub> emissions reductions associated with gas and electric savings, Energy Division used the emission factors that are embedded in the E3 calculators, which are specific to each technology installed. In estimating the number of cars removed from California roads, ED used the factors presented in D.05-09-045, which approved the IOU programs for 2006-2008 and included an estimate of cars removed (1 car for every 5.26 tons of CO<sub>2</sub>).

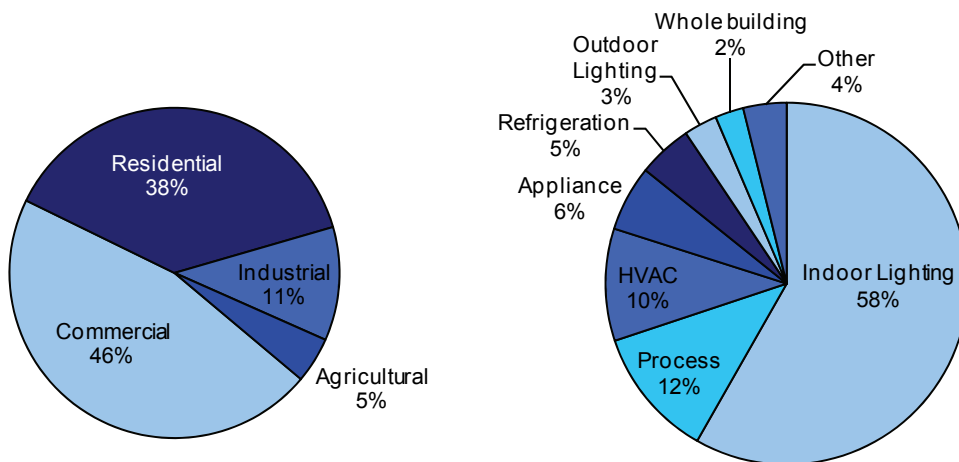
<sup>5</sup> Gross savings represent the total savings resulting from the program activities, regardless of the attribution, or responsibility for achieving those savings. Net savings represent the portion of total (gross) savings that are directly attributable to the IOUs' program activities, after taking out those savings that would have occurred otherwise in the absence of the program (i.e., from "free-riders"). In short, net savings are those that would not have likely occurred in the absence of the program. The error bound for the net savings estimates for GWh, MW and MMtherms are presented in Section 4.3. They are about ±6% for electricity, ±4% for peak, and ±11% for natural gas; results are specific to each utility and fuel type.

- The IOU Energy Centers hosted nearly 550,000 hours of training for nearly 40,000 unique attendees stimulating action among market actors, commercial end users, and residential customers; and,
- The statewide marketing campaign reached 9.5 million households and an average increase in awareness among those households of 10-15% with respect to ways to save energy in the home. The increase in knowledge was greatest among Spanish and Asian language speakers.

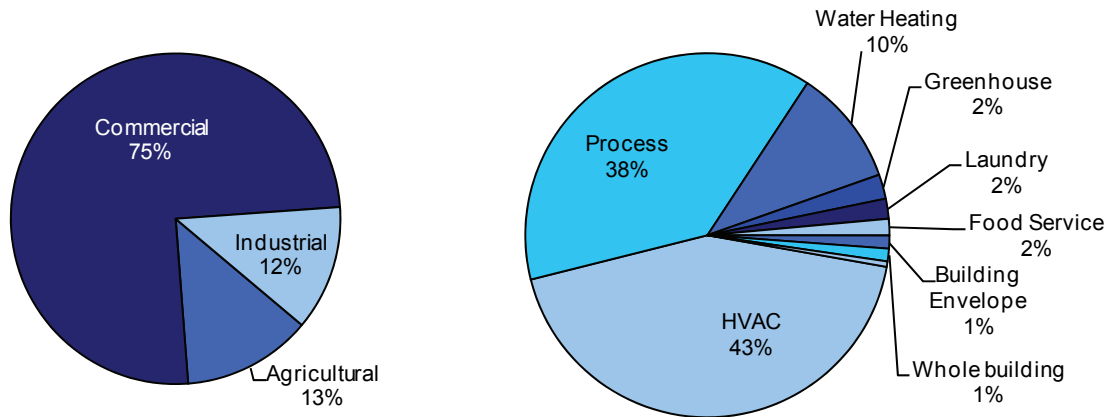
The energy savings impacts presented in this report are limited to the direct savings impacts that resulted from the program activities and by the Commission rules that guided the evaluations. However, the influence of these programs and other energy efficiency activities in the state have very likely led to additional beneficial impacts for the state and beyond California by promoting energy efficiency in the broader market.

The majority of electric energy savings was concentrated in the residential and commercial sectors and primarily attributable to indoor lighting technology installations. The natural gas savings occurred in the commercial, agricultural and industrial sectors and were primarily due to improvements in industrial processes, and improvements in heating, ventilation and cooling systems (HVAC). Although there were natural gas savings in the residential sector, these were negated by interactive effects (which are described in Section 4.5). The figures below illustrate the statewide distribution of evaluated savings by market sector and technology type.

**Figure 1. Electric (GWh) Savings by Market Distribution and Technology Type**

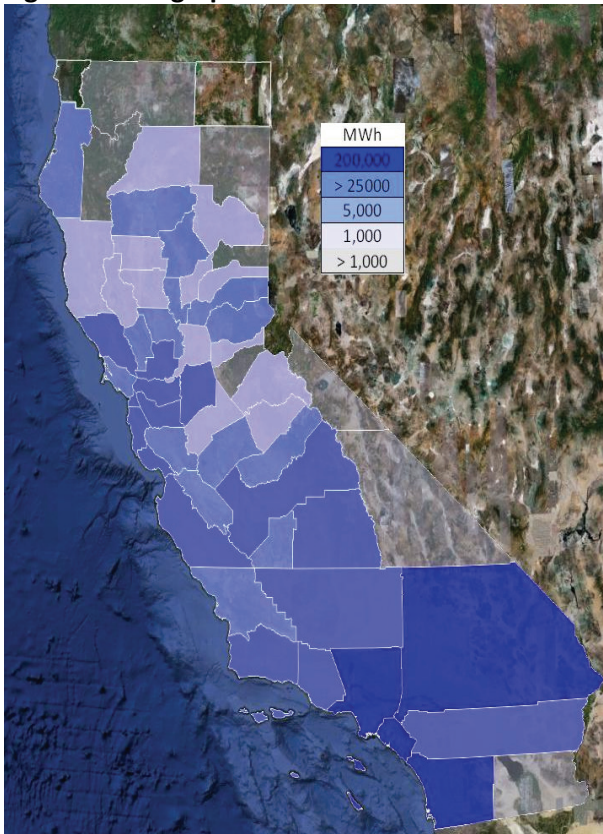


**Figure 2. Natural Gas (MMTherm) Savings by Market Distribution and Technology Type**



The energy savings included in this report are limited to activities pursued by the investor owned utilities in their service territories and were found throughout the state. The following three graphics illustrate the relative savings that occurred in the 58 California counties. The accompanying tables show the twenty counties that achieved the most significant first year (gross or net) savings.

**Figure 3. Geographic Presentation of Net Annual Electric Energy Savings Statewide**

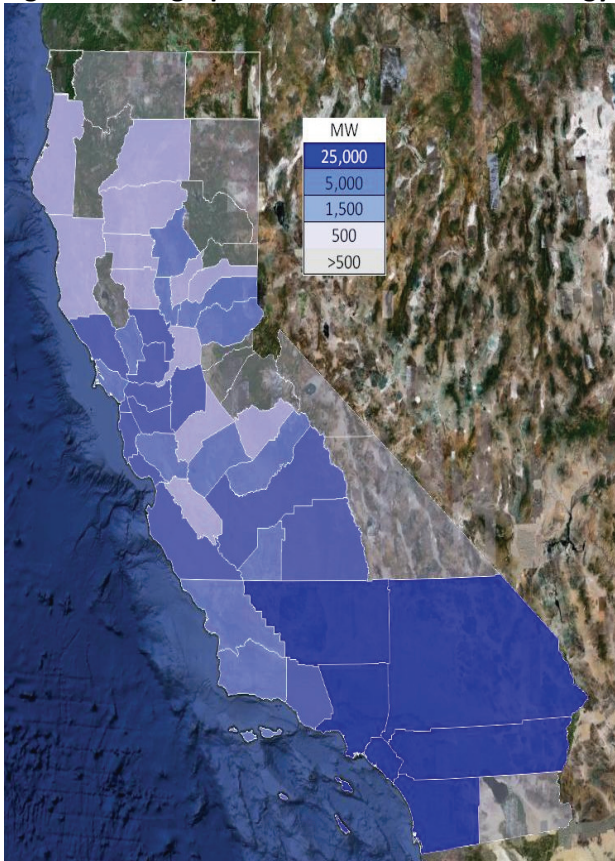


County	kWh Savings
LOS ANGELES	481,681,004
SAN DIEGO	258,413,673
ORANGE	235,097,536
SAN BERNARDINO	209,902,318
RIVERSIDE	137,454,189
KERN	126,781,598
ALAMEDA	125,005,607
SANTA CLARA	107,131,390
FRESNO	81,596,710
SAN JOAQUIN	79,380,830
SAN FRANCISCO	74,215,838
CONTRA COSTA	68,148,279
TULARE	54,176,830
VENTURA	53,352,105
MONTEREY	35,621,808
SOLANO	35,161,928
SAN MATEO	33,564,667
SONOMA	32,598,457
SANTA BARBARA	26,638,293
YOLO	23,693,457

*Upstream lighting savings not included.*



**Figure 4. Geographic Presentation of Peak Energy Savings Statewide**

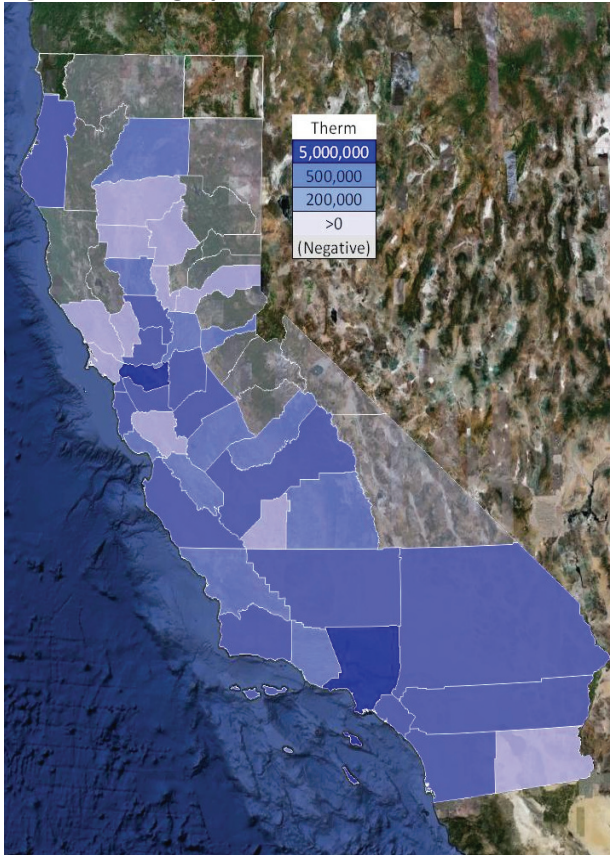


County	kW Savings
LOS ANGELES	99,021
ORANGE	56,318
SAN BERNARDINO	54,201
SAN DIEGO	53,665
RIVERSIDE	37,739
KERN	25,969
ALAMEDA	24,556
FRESNO	21,291
SANTA CLARA	18,743
SAN JOAQUIN	18,171
CONTRA COSTA	15,426
TULARE	15,208
VENTURA	13,372
SAN FRANCISCO	11,809
SAN MATEO	7,147
SOLANO	6,790
YOLO	6,358
SONOMA	6,094
MONTEREY	5,806
PLACER	4,486

*Upstream lighting savings not included.*

The aggregation of energy efficiency data from all four utilities represents a substantial improvement in reporting energy efficiency results and creates numerous opportunities for presenting the data in novel ways. The detailed data tables can be combined using simple queries to answer a variety of quantitative analysis questions and to feed geo-spatial mapping tools. By further combining these data with third party databases, stakeholders have an exhaustive source of custom analytical tools. For example, the vast majority of downstream measures can be located down the zip code level in the public version of the data provided with this report (the ERT). Zip code level data can be combined to show savings and incentives investment by County, Legislative District, or any other superset of zip code areas. Similarly, measure savings can be grouped by technology and climate zone to learn where measures were more or less successful. All of this can be done using simple, open-source tools.

**Figure 5. Geographic Presentation of Annual Natural Gas Savings Statewide**



County	Therm Savings
LOS ANGELES	14,630,965
CONTRA COSTA	8,646,742
SOLANO	3,755,433
SAN BERNARDINO	2,674,433
FRESNO	2,503,199
SANTA CLARA	2,452,679
ORANGE	2,280,726
ALAMEDA	2,229,603
RIVERSIDE	2,227,760
SAN JOAQUIN	2,083,132
SAN DIEGO	2,082,098
STANISLAUS	1,976,884
KERN	1,470,525
SANTA BARBARA	1,376,715
YOLO	1,229,373
SAN FRANCISCO	964,328
SAN MATEO	955,151
MONTEREY	786,882
HUMBOLDT	668,141
AMADOR	409,064

*Upstream lighting not included, therefore significant negative therm impacts are also missing.*

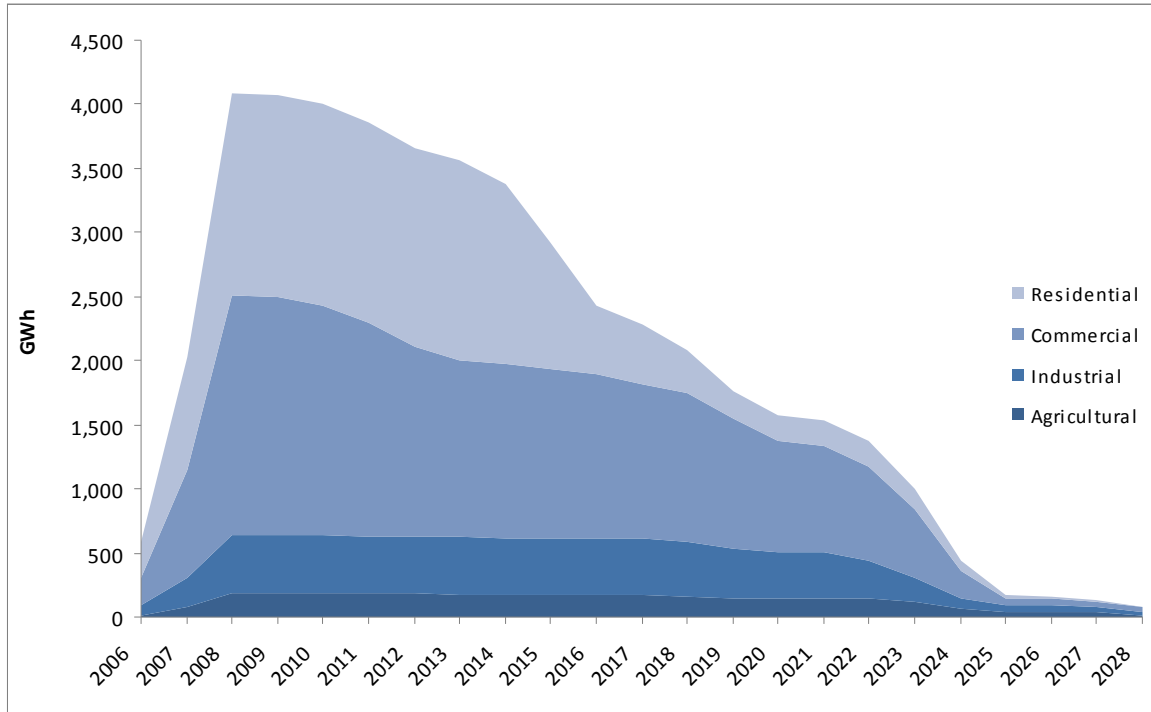
**ES 2.2. Lifecycle Savings Impacts**

The energy efficiency investments made through IOU programs during the 2006-2008 program cycle will produce long-term benefits as long as the installed technologies stay in place, remain operable, and result in continued savings. This persistence has implications both for the lifecycle benefits of an investment made today as well as long-term electric and gas system capacity needs in the future. Figure 3 and Figure 4 illustrate the long-term impacts of these investments in electric and gas energy efficiency for each year through 2028. These long-term savings also form the foundation for meeting the cumulative savings goals into the future (see additional discussion of lifecycle savings in Section 5). The impacts from future or past energy efficiency activities are not included.

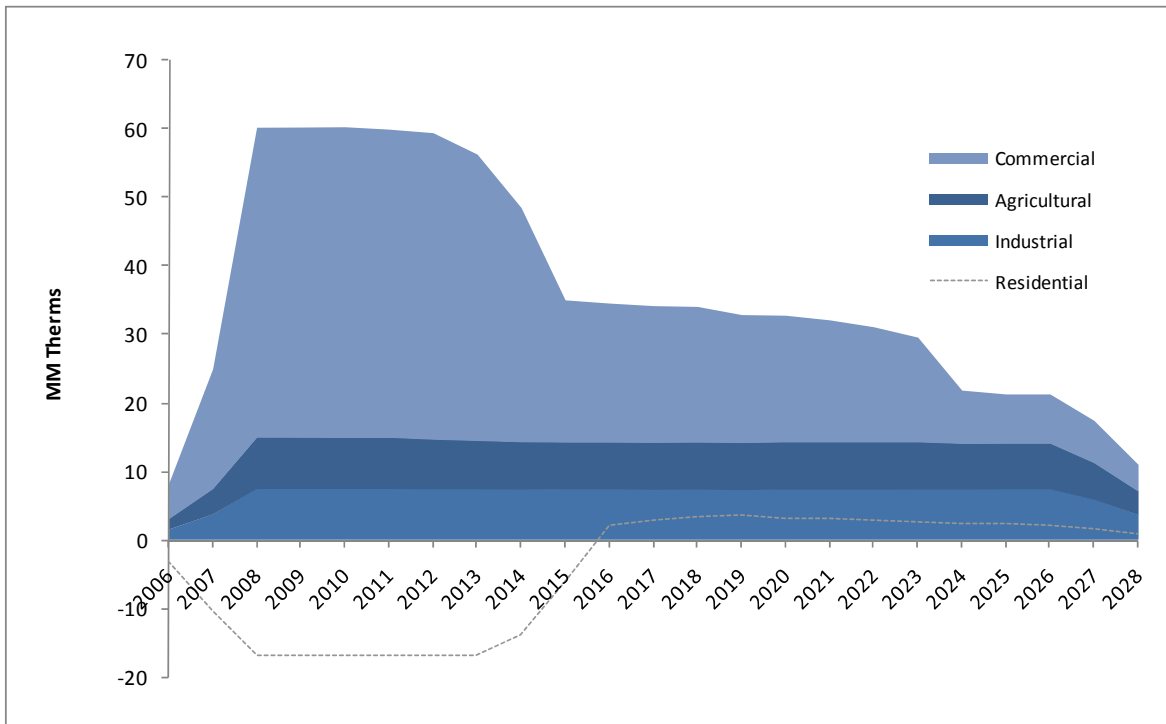
These figures also illustrate the relatively short-lived energy savings impacts of the lighting measures that comprise a majority of the savings from the 2006-2008 program cycle. These short-lived savings from lighting measures are attributable to expected useful lives of only two- to three-years, causing a significant drop in savings after 2010. Longer-term savings were attributable to technologies or actions that are built in, such as insulation and fixtures. Overall, technologies that deliver natural gas savings have greater longevity.

Natural gas savings for the residential sector are illustrated in the following figures as a dotted line to show the negative effects. As residential lighting measures expire the heating load impacts are removed and the natural gas savings return.

**Figure 6. Lifecycle Evaluated Savings - Electric**



**Figure 7. Lifecycle Evaluated Savings- Gas**



### ES 2.3. Cost-Effectiveness

Investments in energy efficiency continue to be one of the least-cost options to meet the state's growing energy needs and reduce greenhouse gas emissions. For the 2006-2008 period, every dollar invested in energy efficiency was earned back with an additional \$.14 in net benefits for the state.<sup>6</sup> Two cost-effectiveness tests are used by the Commission: the Total Resource Cost (TRC) and Program Administrator Cost (PAC) tests. The TRC measures the net resource benefits from the perspective of all ratepayers by combining the net benefits of the program to participants and non-participants. Benefits are the costs of supply-side resources avoided or deferred, while the costs include all those paid by both the utility and participant and encompass costs of the measures and installed equipment and the costs incurred to start and administer the program. Cost-effectiveness is achieved when the value of energy savings (in dollars) is greater than the cost of utility financial incentives to customers and all other program costs. The PAC includes the same benefits as the TRC does, but costs are defined differently to include those incurred by the program administrator but exclude those costs incurred by the customers.

The impact evaluations that Energy Division conducted do not include analysis of program or measure costs or cost effectiveness per se. The cost effectiveness results presented in the following table are calculated based on the monetized benefits of the evaluated net energy savings, compared to the incentive and program costs according to existing rules and do not include any external benefits generated by these programs. Indirect savings estimated by studies of the marketing and outreach, education and training programs, and the savings attributable to the utilities' pre-2005 codes and standards advocacy program, are also not included in the cost effectiveness calculations per Commission direction.

**Table 2. Evaluated Cost Effectiveness of 2006-2008 IOU Energy Efficiency Portfolios**

Millions \$	TRC benefits	TRC Costs	B/C	PAC Benefits	PAC Costs	B/C
PGE	\$1,253	\$1,069	1.17	\$1,253	\$852	1.47
SCE	\$1,169	\$984	1.19	\$1,169	\$638	1.83
SDGE	\$281	\$276	1.02	\$281	\$205	1.37
SCG	\$184	\$205	0.90	\$184	\$116	1.59
Statewide	\$2,886	\$2,534	1.14	\$2,886	\$1,810	1.59

The benefits for these programmatic activities also do not consider the potential long term market effects of the energy efficiency programs. 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 2006-2008 impact evaluations was on the estimation of the immediate and direct impacts of the 2006-2008 programs and therefore did not include these long-term effects. 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.

<sup>6</sup> Please see page 7 of Policy Manual v.4 (<http://www.cpuc.ca.gov/NR/rdonlyres/F17E8579-3409-4089-8DE4-799832CF682E/0/PolicyRulesV4Final.doc>) for details regarding cost-effectiveness calculations.

Even though accounting of costs and benefits has been done strictly according to Commission-adopted rules and practices, in reality utility programs are likely providing additional long-term societal benefits that are not captured in this analysis.

In the 2006-2008 program cycle roughly \$75 million was invested in non-resource programmatic activities that included education and information, marketing and outreach, professional training, and support for emerging technologies. The costs associated with these activities are included in the cost-benefit calculations presented in this report, but Commission policy excludes the indirect energy savings benefits from these programmatic activities for a variety of reasons, the most relevant being the difficulty associated with quantifying and monetizing such benefits in a TRC or PAC framework.

The non-resource evaluations summarized in Section 2.5 of this report identify program effectiveness in raising awareness and encouraging consumer action. In some cases the action is participation in an energy efficiency program (which is captured in the cost effectiveness results in this report), in others instances, a program may lead a customer to take action on their own, which is not captured in the cost effectiveness results. These studies have also quantified indirect energy savings that contribute to the overall societal benefits of investments in energy efficiency programs.

#### **ES 2.4. Evaluation Findings**

The foundation for the 2006-2008 evaluated savings estimates presented in this report are the eleven impact evaluations that were finalized in February 2010.<sup>7</sup> The focus of these studies was to verify reported energy savings and identify energy savings that would not have likely occurred in the absence of the program. Energy Division focused evaluation resources on measuring gross savings from the end-use measures or technologies that dominated the total portfolio savings (“high-impact measures”, or “HIMs”) and on estimating net savings attributable to programs with the highest savings from installed technologies. The HIM approach went beyond a program-by-program evaluation by ensuring that the majority of the portfolio savings were subject to evaluation review.<sup>8</sup> Approximately 85% of the reported kWh, kW and therms were included in the direct evaluation of gross savings.

The evaluations also identify areas where net savings may be limited and indicate areas in which the market may be becoming transformed, meaning that no further utility programs and financial incentives to consumers may be necessary to encourage adoption of these technologies. In such cases, the promotion and placement by manufacturers, retailers and other market actors appears to be driving the natural market for efficient technologies. The evaluations offer specific recommendations for focusing programs and activities in certain areas to better leverage ratepayer investments.

The findings from these studies are currently the focus of meetings between IOU program managers and Energy Division to identify improvements that can be made to similar programs that exist in the 2010-2012 portfolios. These results are most informative when used in combination with process

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<sup>7</sup> Section 2 of this report summarizes the key findings and recommendations from the impact evaluation reports. The full reports are posted on the California Measurement Advisory Council website at [www.calmac.org](http://www.calmac.org).

<sup>8</sup> In D. 07-09-043 the Commission recognized that its staff may not have the resources to evaluate the over 200 programs in the IOUs’ 2006-2008 portfolios and provided staff with the flexibility to establish evaluation priorities throughout the program cycle.

evaluation results and other market studies in order to better explain the success of energy efficiency efforts in California.

Energy savings were highly concentrated in residential lighting and large commercial and industrial process improvements. Consequently, the evaluation results for those aspects of the portfolio were the cause for most of the differences observed between reported and evaluated energy savings. The evaluations offered several suggestions for programmatic changes to realize greater savings in the future. The following findings address the largest impacts on the portfolio savings in this cycle. These findings include but are not limited to:<sup>9</sup>

- Evaluations of CFL lighting programs found that high hours of use assumptions for the standard CFL bulbs resulted in over-estimated energy savings. Program focus on specialty bulbs and smaller retail outlets where energy efficient lighting products remain at lower market shares may offer more opportunities for net savings in the future.
- Significant potential savings exist for large commercial and industrial energy efficiency projects. However, the evaluations identified that many of the projects were likely to have occurred in the absence of the program. Projects should be screened prior to implementation to ensure that net savings are being achieved.

In the course of the evaluations, differences between reported savings and evaluated savings are expected. Reported savings are estimates of savings provided by the utilities, based on their tracking data, using planning assumptions for the savings attributable to specific technologies that are installed. Evaluated savings are a further refinement of reported savings that have been verified and measured through tracking data review, verification of installation, and field measurement. While these values are not expected to be equal; closer alignment of these values will only be achieved if evaluated results continue to be incorporated into planning assumptions.

The gap between reported and evaluated savings has been increasing since the 2002-2003 evaluation cycle. The utilities and the Commission established energy savings targets or goals for each program cycle. Using these goals as a benchmark, over the course of the last three program cycles the gap between reported savings and the goals increased, and the difference between evaluated savings and those same goals has also widened, suggesting far lower levels of actual savings. This trend, illustrated in Table 3, suggests that updated savings estimates based on evaluation results are not being incorporated into projected savings estimates in a timely enough fashion. In addition, the goals themselves, which may be based on similar assumptions, could quickly become outdated. It may also suggest some level of diminishing returns in incremental benefits available from the programs due to rising baseline efficiency level and a general increase in energy efficiency awareness among consumers in the marketplace, as compared to earlier planning assumptions.

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<sup>9</sup> Detailed findings for specific measures and programs can be found in the final evaluation reports.

**Table 3. Reported and Evaluated Net Savings as a Percentage of Savings Goals since 2002\***

Program Cycle	kWh		kW		Therms	
	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated
<b>2002-2003</b>	118%	104%	104%	86%	98%	81%
<b>2004-2005</b>	127%	79%	133%	75%	182%	55%
<b>2006-2008</b>	151%	62%	122%	55%	117%	50%

\*In this table the 2002-2003 and the 2004-2005 accomplishments are compared to IOU program specific goals; and in 2006-2008 the CPUC adopted goal is the point of comparison.

While there are likely several causes for this divergence, it highlights the need for a more dynamic evaluation feedback and update process that potentially can be applied to goals and estimates of program savings. An updated and more dynamic evaluation process would potentially stabilize this trend, build confidence in the expected savings, and enable timely program design changes in response to evaluation findings and market changes to maximize their impact.

The foundation of the goals may also contribute to this divergence. The goals for the last two program cycles (2004-2005 and 2006-2008), were developed from analyses conducted in 2002 to 2004. As a result, there are inconsistencies between the savings estimates from the most recent evaluation results and the assumptions and data underlying the original energy efficiency forecasts used to support the CPUC's efficiency goals. New information on energy efficiency market penetration, end user adoption rates, and per unit savings levels developed through evaluations and other research conducted since the original goals were developed and this information should inform future updates to the goals. The CPUC deliberately set challenging energy efficiency goals for the IOUs' 2006-2008 programs, and it appears that market forces are contributing to a larger share of energy savings than were forecasted in the studies used to inform the current CPUC's goals.

### **ES 3. Notable Accomplishments of the 2006-2008 Program Evaluation Cycle**

The 2006-2008 program evaluation cycle produced a number of notable achievements. The evaluation marks the first time all portfolios were evaluated using consistent methods that followed the California Energy Efficiency Evaluation Protocols<sup>10</sup> and produced standard data sets compiled across IOUs at the technology level. This was accomplished with the cooperation and significant contributions of the IOUs and enables aggregation of savings and other parameters across IOUs, technologies, and programs. The data compiled from the evaluation will be centralized in a single location as a rich body of non-proprietary data for use in future analysis and program cycles.

Additionally, Energy Division staff completed one of the largest energy efficiency impact evaluations in the world, managing a budget of \$97 million spread across 23 technical contracts within strict timelines and a rigorous public review process. Energy Division has significantly expanded its understanding of energy efficiency sectors and IOU programs, and will apply that knowledge and the evaluation results, in collaboration with the IOUs, to implementation of the 2010-2012 programs and evaluation. Future evaluations will also benefit from the evaluation methods developed by Energy Division for the 2006-2008 program cycle, including the use of a technology-based approach (HIMs), that resulted in deeper analysis of and a greater confidence in the savings measured for existing technologies.

Energy Division staff will also collaborate with the CEC and the Long-Term Procurement Plan proceeding staff to ensure that the forecasting activities reflect the best available information regarding the performance of the 2006-2008 energy efficiency programs, as well as the future goals. Finally, the results of the 2006-2008 evaluation will inform the Risk-Reward Incentive Mechanism proceeding.

### **ES 4. Energy Division Key Recommendations**

Energy Division staff offer the following programmatic and evaluation recommendations based on their experience and feedback from stakeholders and evaluation consultants over the course of the evaluation cycle. These recommendations are discussed further in Section 9 of this report.

#### **Recommendations for Programmatic Action**

- Results from the evaluations should be used for continuously improving savings estimates and informing program design in the 2010-2012 cycle and beyond.
- Program implementers must improve program tracking data collection and maintenance to ensure proper accounting for the technologies installed and actions taken so proper credit can be given.
- Program implementers must take steps to ensure that program rules guiding eligibility are followed.
- Program implementers should screen large project participants to ensure that net savings are achieved, not those that would have occurred absent the program.

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<sup>10</sup> Available at [http://www.calmac.org/events/EvaluatorsProtocols\\_Final\\_AdoptedviaRuling\\_06-19-2006.pdf](http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf).



- Portfolios should diversify their offerings so savings are not so heavily concentrated in one technology, as they were for standard compact fluorescent bulbs in the 2006-2008 program cycle.

#### **Recommendations for Evaluation Changes**

- Continue to improve collaboration with implementers and other stakeholders to build the value of evaluation products and results.
- Future evaluation studies should be designed and implemented in coordination with program implementation to have greater influence on mid-course corrections and improving estimates along the way. On-going program improvement should be prioritized over static and regular reporting of evaluation results.
- Review of cost data submitted by the utilities, including the costs of installed technologies or measures within the programs, must be integrated into future energy efficiency evaluations to appropriately measure cost-effectiveness of the portfolios.
- Early notification strategies should be implemented to enable participation by evaluators prior to installation of the technology or other actions taken by program implementers, to enable pre-installation measurements and better capture the impact of the intervention.

#### **Recommendations for Commission Action**

- The Commission should consider evaluation priorities for future program cycles that recognize expanded program and policy objectives for energy efficiency. The evaluation framework for 2006-2008 may not address the multiple and diverse evaluation needs for meeting AB32, the California Strategic Plan for Energy Efficiency, and Long-Term Procurement Plan objectives.
- In the EM&V white paper issued by ruling on April 16, 2009 in R.09-01-019 and A.08-07-021, the Energy Division recommended that the Commission consider a process for determining utility energy efficiency earnings that is segregated from the measurement of savings and cost-effectiveness analysis in order to remove disincentives to making productive use of the information generated by the EM&V work and to encourage the pursuit of all Commission energy efficiency policy goals. ED continues to recommend that the Commission consider such alternatives for earnings, but notes that the potential downsides of such a mechanism may still need to be more fully explored within the Commission's proceedings.

## ES 5. Policy Context for the 2006-2008 Program Evaluation Cycle

In January 2006, the Commission issued an Administrative Law Judge Ruling that defined the reporting requirements and timeline for the 2006-2008 energy efficiency program cycle. The ALJ Ruling<sup>11</sup> called for three types of reports to be issued throughout the program cycle that would verify the level of energy and peak savings achieved by the IOUs' energy efficiency programs and determine the performance basis for each administrator's portfolio of programs. This process was later refined and updated in 2007 and 2008, when the Commission directed Energy Division to:

- verify the costs and installations of the energy efficiency program activities,
- update the ex-ante parameters used to estimate program savings and benefits, and
- publish reports that calculate the earnings the utilities are eligible to claim.<sup>12</sup>

The reports produced by Energy Division over the program cycle as well as their content, purpose and timing are listed in Table 4. This report is the final summary of the achievements for the 2006-2008 program cycle.

**Table 4. Energy Division Reporting Requirements for 2006-2008**

	Annual Verification Report (VR)	Final Evaluation Reports from EM&V Contractors	Energy Division Final 2006-2008 Evaluation Report
<b>Content</b>	Savings by utility adjusted by verified installations and using ex-ante DEER parameters	Evaluation results on key technology savings and parameters used to calculate savings.	Savings by utility and program based on evaluation results
<b>Purpose</b>	Verify the number of installations and portfolio and program costs	Present evaluation findings from 16 EM&V projects: Resource and Non-Resource evaluations	Program and portfolio accomplishments  Explain methods and process used
<b>Timeline</b>	2006-2007 VR report finalized Feb. 2009  2006-2008 VR Finalized: Oct. 2009	Drafts posted for public review:  December 2009; Finalized Feb 2010	Draft for public review April 2010 Final June 2010

The evaluation work was designed to meet the reporting requirements for the 2006-2008 evaluation cycle described in Table 4. Figure 5 presents the evaluation research workflow that concludes with this report.

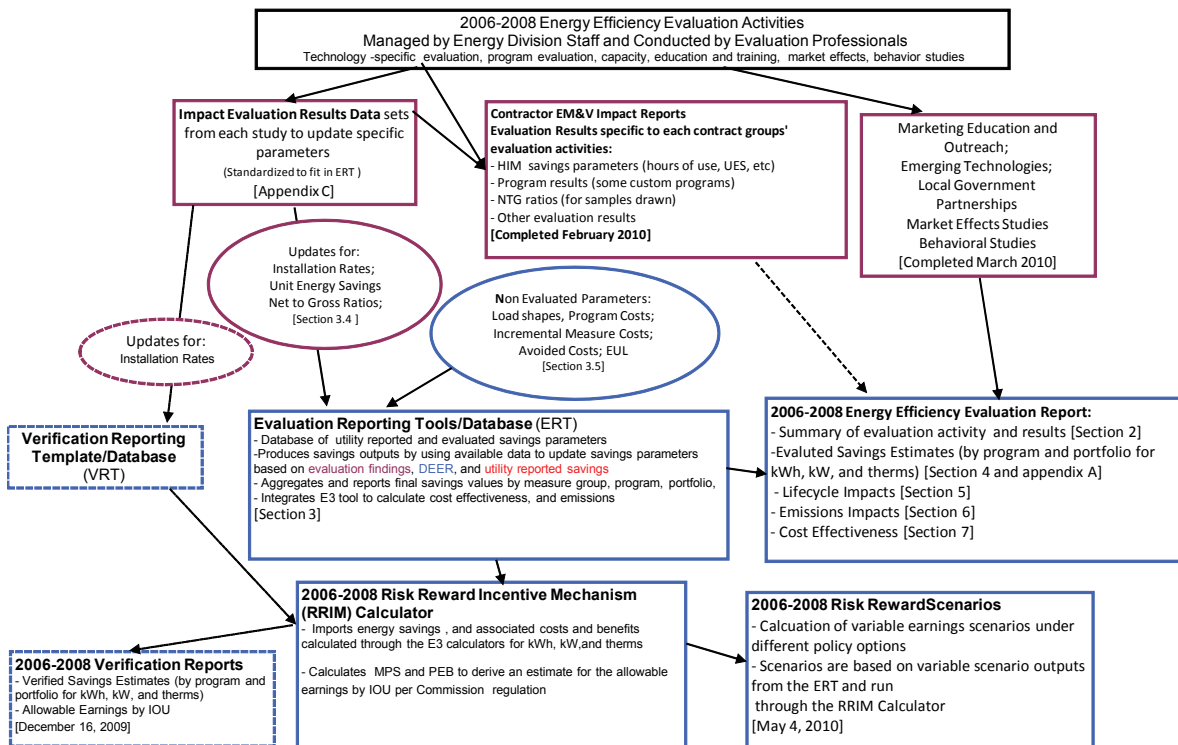
<sup>11</sup> See "Administrative Law Judge's Ruling Adopting Protocols for Process and Review of Post-2005 Evaluation, Measurement and Verification (EM&V) Activities, available at <http://docs.cpuc.ca.gov/PUBLISHED/RULINGS/52676.htm> .

<sup>12</sup> See Decisions 07-09-043 and 08-01-042, at [http://docs.cpuc.ca.gov/WORD\\_PDF/FINAL\\_DECISION/73172.PDF](http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/73172.PDF) and [http://docs.cpuc.ca.gov/WORD\\_PDF/FINAL\\_DECISION/78370.PDF](http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/78370.PDF), respectively. The Assigned Commissioner in the incentive rulemaking proceeding (R.09-01-019) issued a ruling (ACR) on April 8, 2010, providing guidance on the process for finalizing the true-up of incentive earnings under the Risk/Reward Incentive Mechanism (RRIM) for 2006-2008. The ACR directs Energy Division to issue a separate report on May 4, 2010, presenting various scenario analyses that can be used to inform the final incentive earnings for the 2006-2008 program cycle.

Energy Division hired evaluation consultants in August 2007. Under Energy Division oversight, the evaluation consultants submitted draft evaluation plans for public review in late 2007, began their impact evaluation field work in early 2008, and completed their research by the fall of 2009. Evaluations of non-resource programs were conducted concurrently with the impact evaluations.

In late 2008, Energy Division refined the evaluation plans to focus evaluation resources on measuring gross savings from the end-use measures that dominated the total portfolio savings (“high-impact measures”, or “HIMs”) and on estimating net savings attributable to programs with the highest savings.

**Figure 8. Relation of Evaluation Activities, Results and Reporting**



Results from the impact evaluations were posted for public review and comment in December 2009 in detailed technical reports, and were also presented in public webinars. The public comment period generated approximately 1,700 comments, all of which were addressed by Energy Division and its evaluation contractors. The reports were finalized in February 2010; summaries of these report findings are included in Section 2 of this report, and the final reports are posted on the California Measurement and Advisory Council (CALMAC) website.<sup>13</sup>

The data presented in the final evaluation reports allowed Energy Division to update estimates of and report on specific energy savings parameters for this report, as directed by the ALJ Ruling issued in R.01-08-028 on January 11, 2006<sup>14</sup>. Energy Division required the evaluation contractors to submit

<sup>13</sup> See [www.calmac.org](http://www.calmac.org).

<sup>14</sup> See “Administrative Law Judge’s Ruling Adopting Protocols for Process and Review of Post-2005 Evaluation, Measurement and Verification (EM&V) Activities, available at <http://docs.cpuc.ca.gov/PUBLISHED/RULINGS/52676.htm>.

study results in a standardized format consistent with the official cost-effectiveness tools, and in a format that would relate to the utility reported savings at the most detailed technology level. Energy Division also developed the “Decision Framework” (see Section 3.5), a guidance document for the evaluation contractors to ensure that their datasets and parameter-specific updates were consistent and in accordance with policy requirements. The evaluation contractors were to provide updates to installation rates (how many technologies were installed and operating), unit energy savings (savings for any given technology), and net to gross ratios (a factor used to adjust savings to account for the influence of the program) where evaluation updates were available. Several parameters, primarily cost data, were part of the data set but were not updated with evaluation results. (The updates that were applied, the source of the update and the justification of the values were provided by each group, and are presented in Appendix C.)

All of the evaluated and utility-reported data points were imported into the Evaluation Reporting Tools (ERT) Application database to produce aggregate impacts by utility, program or measure. The ERT, which is discussed in Section 3 of this report, also allowed for the aggregation of evaluation results from the measure-specific evaluations (HIM designs) which cut across programs. The resultant data set provides estimates of savings, benefits, and costs for each IOU, specific programs, and technologies. The ERT also allows for parameter updates to be “on” or “off” to gauge the relative influence of any given evaluation update on the reported savings. The energy savings, lifecycle savings, emissions, and cost effectiveness information presented in this report are based on evaluation results and subsequent ERT outputs.

The Evaluation Reporting Tools also include the necessary data for calculating allowable utility earnings via the Risk Reward Incentive Mechanism (RRIM) Calculator. The application of results presented in this report will be included in a report from Energy Division in early May 2010 that will specifically address the Risk Reward Incentive Mechanism (RRIM).<sup>15</sup>

## **ES 6. Summary of Evaluations Conducted in 2006-2008 Cycle**

The 2006-2008 Resource and Non-Resource Impact Evaluation Reports were finalized in February 2010. These reports form the foundation for updating the utility reported savings estimates based on field evaluation for the measures that made up the most significant portions of the portfolios. The completion of these studies represents the culmination of nearly three years of field-based evaluation research directed by Energy Division staff and implemented by leading evaluation professionals from 60 different firms. These evaluation reports were subject to a public review process and provide key information regarding technology performance and specific market approaches for achieving energy efficiency savings.

The Final Evaluation Reports present evaluation results for the sixteen contract groups that comprised the impact and certain process evaluation projects. The evaluation projects were split between eleven contract groups that evaluated resource programs and five contract groups that evaluated non-resource programs.<sup>16</sup>

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<sup>15</sup> See footnote 12 for background on the RRIM report.

<sup>16</sup> Resource programs use incentives to encourage customers to adopt or install specific energy efficiency technologies and measures and produce measurable energy savings that occur as a result of such investments. Non-resource programs may not produce measurable energy savings but support energy efficiency objectives through innovative programs, pilot-testing, marketing, education and outreach efforts that provide education for customers

## Evaluation Teams for the 2006-2008 Program Evaluation Cycle

Evaluation Contract Group	Energy Division Project Manager	Lead Evaluation Firm	Evaluation Budget
<b><u>Resource</u></b>			
<b>New Construction/ Codes &amp; Standards</b> <i>HIM: Whole Building</i>	Ayat Osman	KEMA	\$7.0 million
<b>Residential Retrofit/Upstream Lighting</b> <i>HIM: CFL, Outdoor CFL, Clothes Washer, Insulation, Interior Screw Lighting, Linear Fluorescent, Pool Pump, Refrig. Recycling, Room AC, Dishwashers, Furnaces, High Eff. Gas Water Heaters, Low-flow shower aerators</i>	Mikhail Haramati	Cadmus	\$18.7 million
<b>Commercial Retro-commissioning</b> <i>HIM: Retro-commissioning</i>	George Tagnipes	SBW	\$3.2 million
<b>Local Government Partnerships</b>	George Tagnipes	Summit Blue	\$7.9 million
<b>Major Commercial</b> <i>HIM: On-site Audit, custom lighting, custom HVAC, custom other</i>	George Tagnipes	SBW	\$4.9 million
<b>Small Commercial</b> <i>HIM: high-bay fluorescent</i>	George Tagnipes	Itron	\$8.9 million
<b>Specialized Commercial</b> <i>HIM: Refrigerant Charge Airflow, AC replacement, Duct Sealing</i>	George Tagnipes	KEMA	\$4.6 million
<b>Commercial Facilities</b> <i>HIM: Refrigeration Door Gasket and Strip Curtains</i>	Kay Hardy	ADM	\$3.2 million
<b>PG&amp;E Agricultural &amp; Food Processing</b> <i>HIM: Greenhouse Heat Curtains and IR Film</i>	Kay Hardy	KEMA	\$1.7 million
<b>PG&amp;E Fabrication, Process &amp; Manuf.</b> <i>HIM: Pump-off controllers</i>	Kay Hardy	Itron	\$4.3 million
<b>SCE Industrial &amp; Agriculture</b> <i>HIM: Pump tests, Steam Traps, Pipe Insulation</i>	Kay Hardy	Itron	\$4.4 million
<b><u>Non-Resource</u></b>			
Emerging Technologies	Ayat Osman	Summit Blue	\$2.0 million
Local Government Partnerships	Jean Lamming	Summit Blue	(a)
Statewide Education and Info.	Pam Wellner	Opinion Dynamics	\$2.8 million
Statewide Marketing/Outreach	Pam Wellner	Opinion Dynamics	\$2.0 million
Statewide EE Education/Training	Pam Wellner	Opinion Dynamics	\$2.8 million
(a) within the Local Government Partnerships Resource Evaluation			

Energy Division also conducted several Market Effects studies for the 2006-2008 program cycle. The purpose of these market effects studies was to understand and quantify market structural and operational changes that occurred as a result of the IOU programs.

on the benefits of energy efficiency as well as pushing for energy efficiency technologies and practices through advocacy programs such as the Codes and Standards programs.

**2006-2008 Market Effects Studies**

Evaluation Contract Group	Energy Division Project Manager	Lead Evaluation Firm	Evaluation Budget
<b>Market Effects Studies</b>			
CFL Market Effects	Mikhail Haramati	KEMA	\$1,082,000
High Bay Lighting	Peter Franzese	KEMA	\$340,000
New Construction	Ayat Osman	KEMA	\$822,000

In addition to the resource and non-resource impact evaluations, nine behavior studies were conducted by the California Institute for Energy and Environment (CIEE) during the 2006-2008 program cycle on behalf of the CPUC. The studies explored the future of behavior and energy and determined that additional research and outreach activities should be supported by the Commission to ensure that behavioral issues are integrated in the implementation of energy efficiency programs. A list of the behavior studies that includes more detailed descriptions of research objectives is included in Section 2.

**2006-2008 Behavior Studies**

Behavior Study	Energy Division Project Manager	Lead Firm
Energy efficiency potential studies and behavior	Pam Wellner	CIEE
Measurement and evaluation of energy savings and non-energy impacts from energy efficiency behaviors	Pam Wellner	CIEE
Process evaluation’s insights on energy efficiency program implementation	Pam Wellner	CIEE
Behavioral assumptions underlying energy efficiency nonresidential programs	Pam Wellner	CIEE
Behavioral assumptions underlying energy efficiency residential programs	Pam Wellner	CIEE
Market segmentation and energy efficiency program design.	Pam Wellner	CIEE
Experimental design for energy efficiency programs.	Pam Wellner	CIEE
Motivating policymakers, program administrators, and program implementers to pursue behavioral change strategies.	Pam Wellner	CIEE
Encouraging greater innovation in the production of energy-efficient technologies and services.	Pam Wellner	CIEE

In addition, the IOUs conducted 27 process evaluations that provided key information to program implementers about their programs’ abilities to reach the targeted population and meet other objectives. In addition the IOUs conducted five combined market assessment/process evaluation studies, four market studies, and eight early M&V studies. The findings of these studies have been or will be incorporated into the programs as on-going improvements and will influence planning of future programs.

## **ES 7. Impacts by IOU**

The four largest IOUs serve over two-thirds of total electricity demand and over three-quarters of natural gas demand throughout California.<sup>17</sup> Under the 2006-2008 administrative framework adopted by the CPUC for energy efficiency, the IOUs were responsible for implementing the energy efficiency programs in the state. Additionally, the energy efficiency investments made through IOU programs during the 2006-2008 program cycle will produce long-term benefits as long as the installed technologies stay in place, remain operable and result in continued savings. This persistence has implications both for the lifecycle benefits of an investment made today as well as long-term capacity needs in the future. These long-term savings also form the foundation for meeting cumulative savings goals into the future.

The evaluated and lifecycle impacts for each IOU are presented in this section.

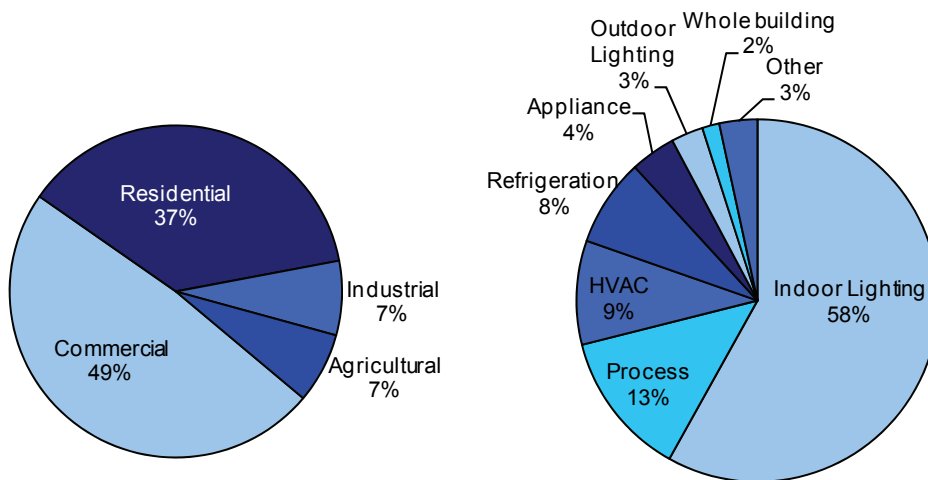
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<sup>17</sup> CPUC Annual Report 2008, available at: <http://www.cpuc.ca.gov/NR/rdonlyres/F7CE31C1-64AF-4656-8646-57E2D52264E2/0/CPUC2008AnnualReport.pdf>.

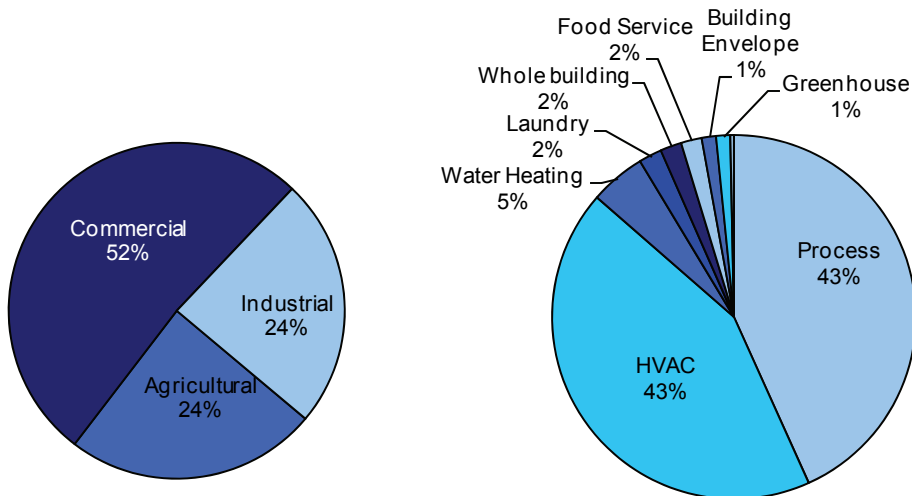
**ES 7.1. Pacific Gas and Electric**

In the 2006-2008 program cycle, the majority of PGE’s electric savings impacts was found in the residential and commercial sectors and achieved through the installation of indoor lighting technologies. Natural gas savings were found in the commercial and industrial sectors, primarily through HVAC and process measures. Natural gas savings were also achieved in the residential sector, however in the early annual savings these are outweighed by increases in heating load from more efficient indoor lighting and refrigeration.

**Figure 9. PGE Electric Savings by Market Distribution and Technology Type**



**Figure 10. PGE Natural Gas Savings by Market Distribution and Technology Type**





**Table 5. PGE Savings Impacts**

2006-2008	Annual Impacts <sup>18</sup>		Lifecycle Impact		% of 2008 sales Gross
	Gross	Net	Gross	Net	
<b>Reported Savings</b>					
GWh	6,292	5,251	57,486	46,603	7%
MW	994	845			
MMTherm	83	66	1,404	1,091	3%
<b>Evaluated Savings</b>					
GWh	2,999	1,766	30,315	18,537	3%
MW	513	320			
MMTherm	47	22	918	411	2%
<b>2006-2008 Program Cycle Goal</b>					
GWh		2,826			3%
MW		613	<i>No lifecycle goals</i>		
MMTherm		45			2%
<b>Emissions Reductions</b>					
Tons of CO <sub>2</sub> Avoided	1,909,936	1,201,013	21,914,044	10,368,241	

Based on evaluated results, the cost effectiveness of these efforts for PGE was still well over 1.0. The Total Resource Cost test was 1.28 and the Program Administrator Test registered 1.64. In contrast, based on PGE’s reported savings, the TRC and PAC ratios were 2.8 and 4.0 respectively.

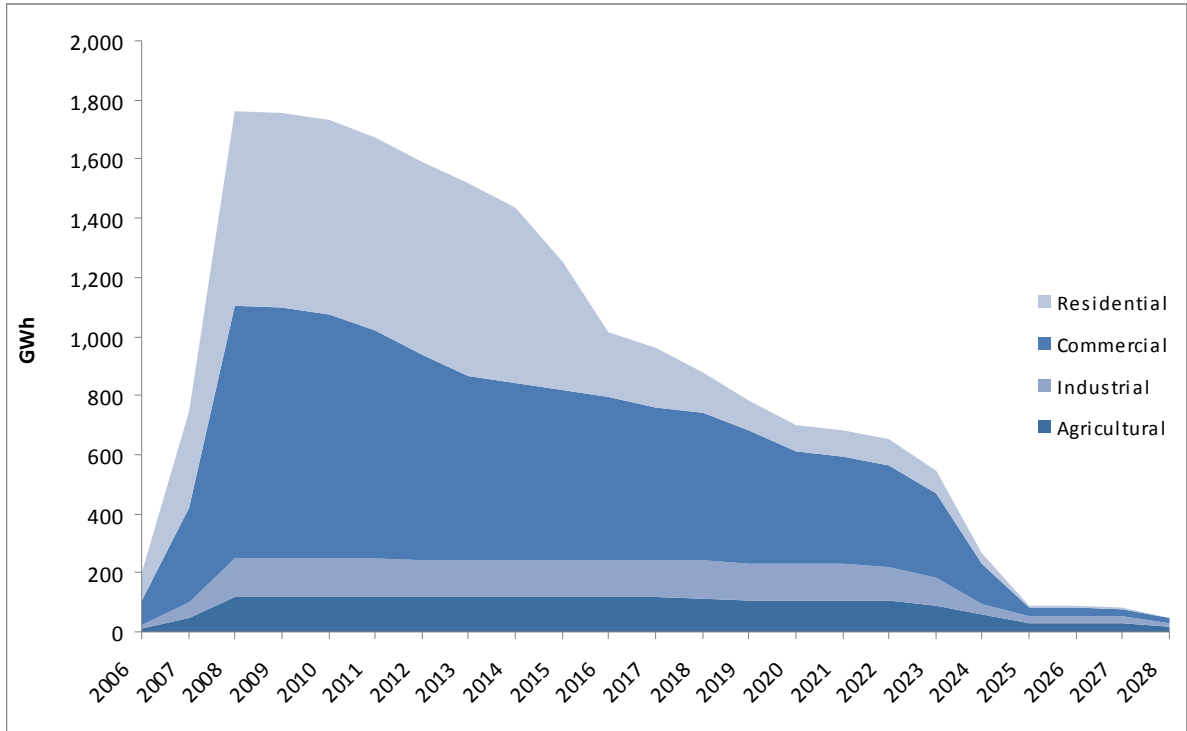
**Table 6. PGE TRC / PAC**

	Benefits	Costs	Ratio
<b>Total Resource Cost Test (TRC)</b>	\$1,253	\$1,069	1.17
<b>Program Administrator Cost Test (PAC)</b>	\$1,253	\$852	1.47

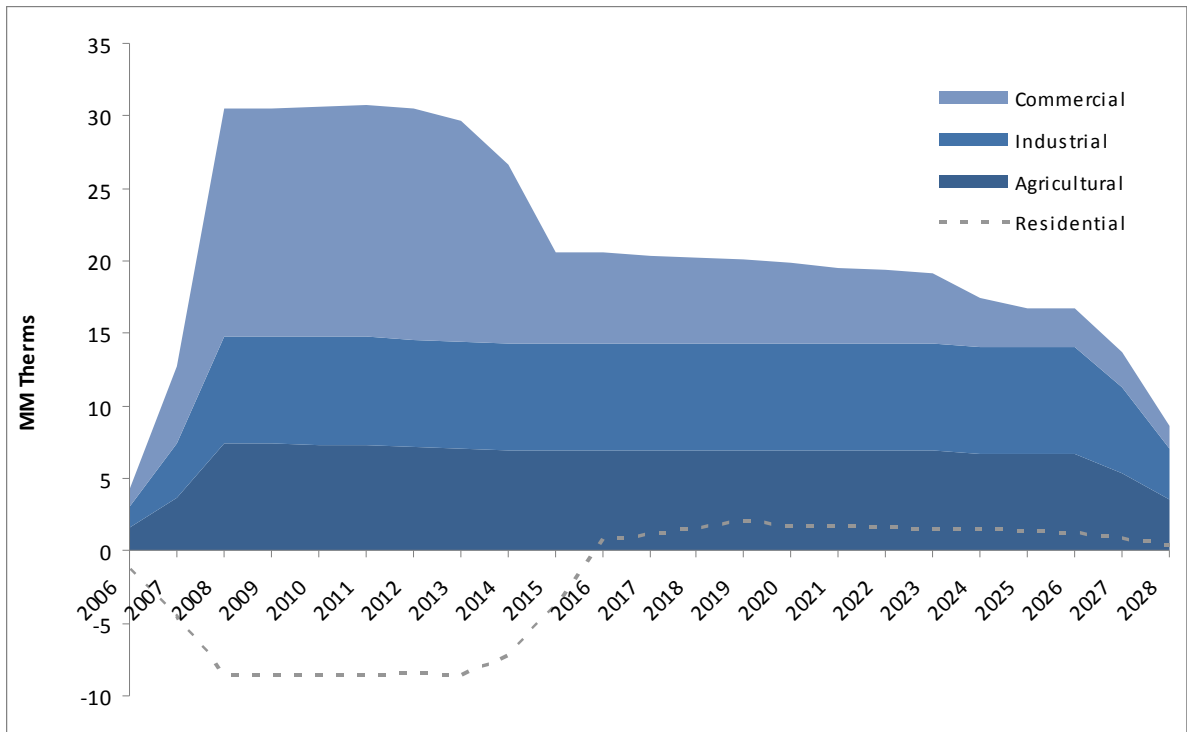
Figure 11 and Figure 12 illustrate the long-term impacts of these investments in electric and gas energy efficiency for the next 20 years.

<sup>18</sup> The error bound on the net evaluated savings are ±4.5% for GWh, ±3.2% for MW and ±13.5% for natural gas; details about the methodology are presented in section 4 of this report.

**Figure 11. PGE Lifecycle Evaluated Savings-Electric**



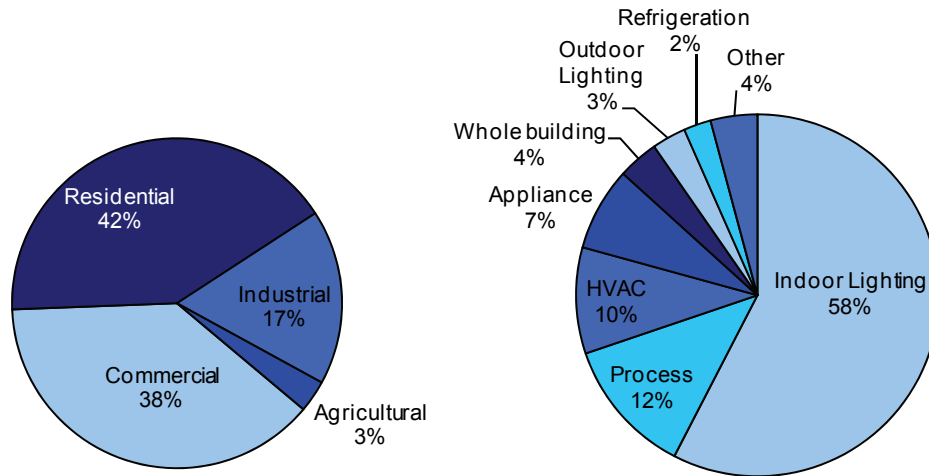
**Figure 12. PGE Lifecycle Evaluated Savings -Gas**



**ES 7.2. Southern California Edison**

In the 2006-2008 program cycle the majority of SCE’s electric savings impacts was found in the residential and commercial sectors and achieved through the installation of indoor lighting technologies.

**Figure 13. SCE Savings by Market Distribution and Technology Type**



**Table 7. SCE Savings Impacts**

2006-2008	Annual Impacts <sup>19</sup>		Lifecycle Impact		% of 2008 sales Gross
	Gross	Net	Gross	Net	
<b>Reported Savings</b>					
GWh	5,100	3,898	46,769	35,506	5%
MW	885	690			
<b>Evaluated Savings</b>					
GWh	2,936	1,963	29,719	20,029	3%
MW	551	384			
<b>2006-2008 Program Cycle Goal</b>					
GWh		3,135			3%
MW		672	<i>No Lifecycle Goals</i>		
<b>Emissions</b>					
Tons of CO <sub>2</sub> Avoided	1,553,567	1,046,414	15,992,515	11,372,622	

<sup>19</sup> The error bound on the net evaluated savings are ±5.9% for GWh and ±3.0% for MW; details about the methodology are presented in section 4 of this report.

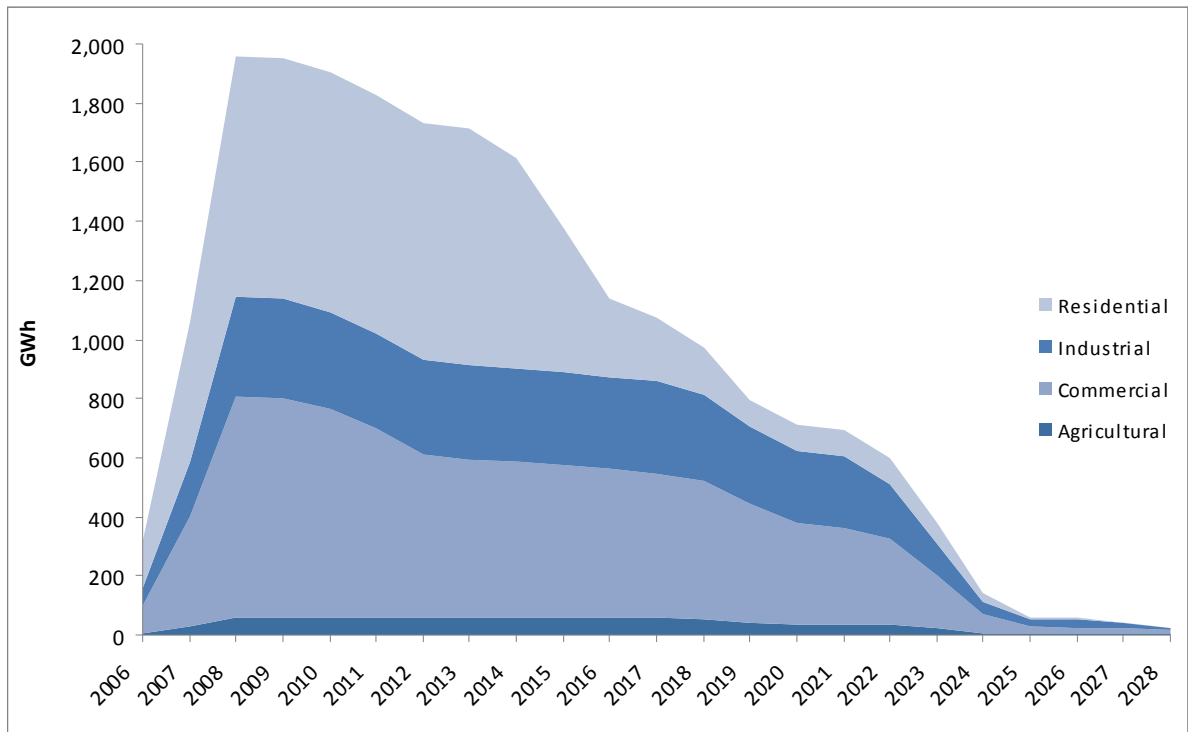
SCE met the cost effectiveness threshold based on evaluated savings. As calculated with SCE’s reported savings, their TRC and PAC were 2.26 and 3.52 respectively.

**Table 8. SCE TRC / PAC**

	Benefits	Costs	Ratio
<b>Total Resource Cost Test (TRC)</b>	\$1,169	\$984	1.19
<b>Program Administrator Cost Test (PAC)</b>	\$1,169	\$638	1.83

Figure 14 illustrates the long-term impacts of these investments in electric energy efficiency for the next 20 years.

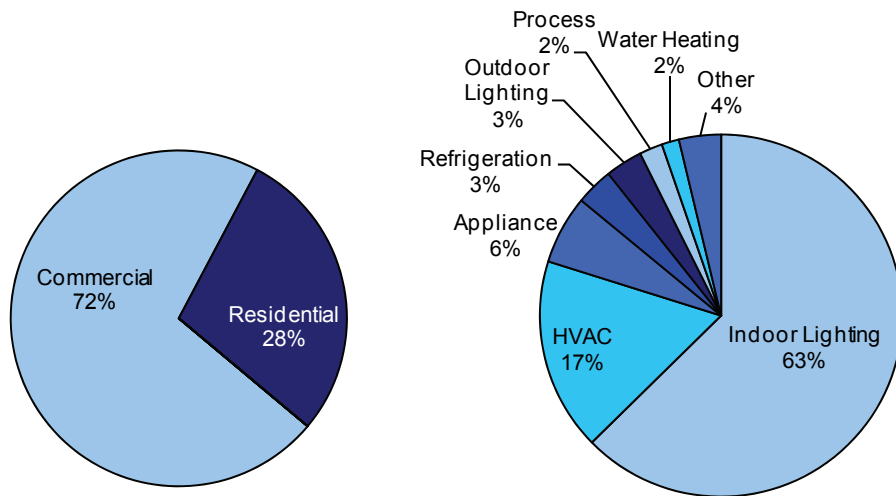
**Figure 14. SCE Lifecycle Evaluated Savings -Electric**



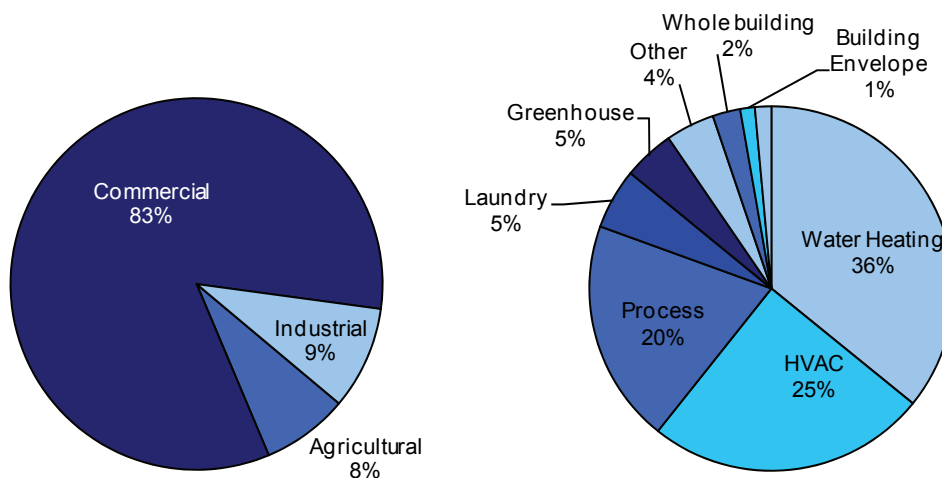
### ES 7.3. San Diego Gas and Electric

In the 2006-2008 program cycle, SDGE’s electric savings impacts were found in the residential and commercial sectors and achieved through the installation of indoor lighting technologies. Like PGE and SCE, the majority of SDGE’s electric savings came from indoor lighting. Natural gas savings in SDGE’s territory occurred primarily in the commercial sector, through water heating, HVAC, and process measures. Natural gas savings were also achieved in the residential sector, however in the early annual savings these are outweighed by increases in heating load from more efficient indoor lighting and refrigeration.

**Figure 15. SDGE Electric Savings by Market Distribution and Technology Type**



**Figure 16. SDGE Natural Gas Savings by Market Distribution and Technology Type**



**Table 9. SDGE Savings Impacts**

2006-2008	Annual Impacts <sup>20</sup>		Lifecycle Impact		% of sales Gross
	Gross	Net	Gross	Net	
<b>Reported Savings</b>					
GWh	1,035	850	10,418	8,494	8%
MW	175	147			
MMTherm	8	7	103	86	1.1%
<b>Evaluated Savings</b>					
GWh	554	364	5,967	4,100	4%
MW	106	72			
MMTherm	3.3	2.7	51	37	0.46%
<b>Goal</b>					
GWh		638			5%
MW		122	<i>No lifecycle goals</i>		
MMTherm		10			1.4%
<b>Emissions</b>					
Tons of CO <sub>2</sub> Avoided	333,325	222,786	3,676,759	2,343,154	

Based on evaluated savings, SDGE met the TRC cost effectiveness threshold and did exceed the PAC test. It is important to remember that there are many benefits that these programs contribute that are not included in the TRC test. As calculated with SDGE’s reported savings, the TRC and PAC estimates were 2.19 and 2.93 respectively.

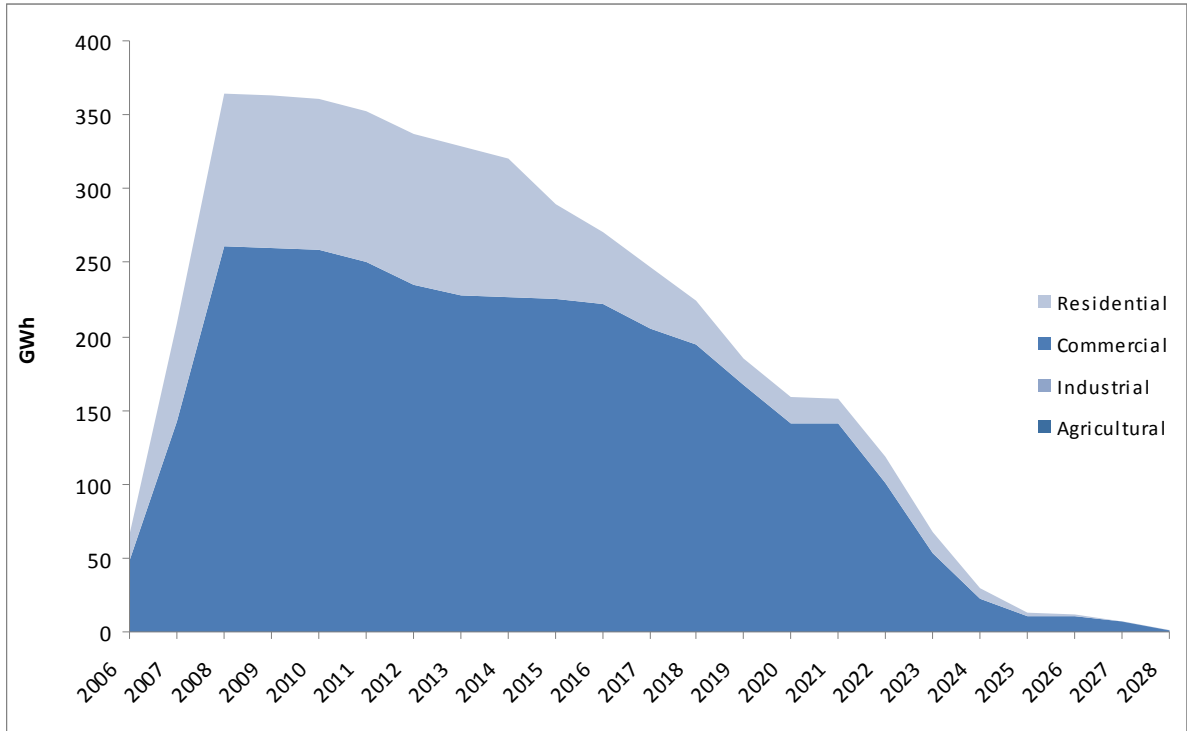
**Table 10. SDGE TRC / PAC**

	Benefits	Costs	Ratio
<b>Total Resource Cost Test (TRC)</b>	\$281	\$276	1.02
<b>Program Administrator Cost Test (PAC)</b>	\$281	\$205	1.37

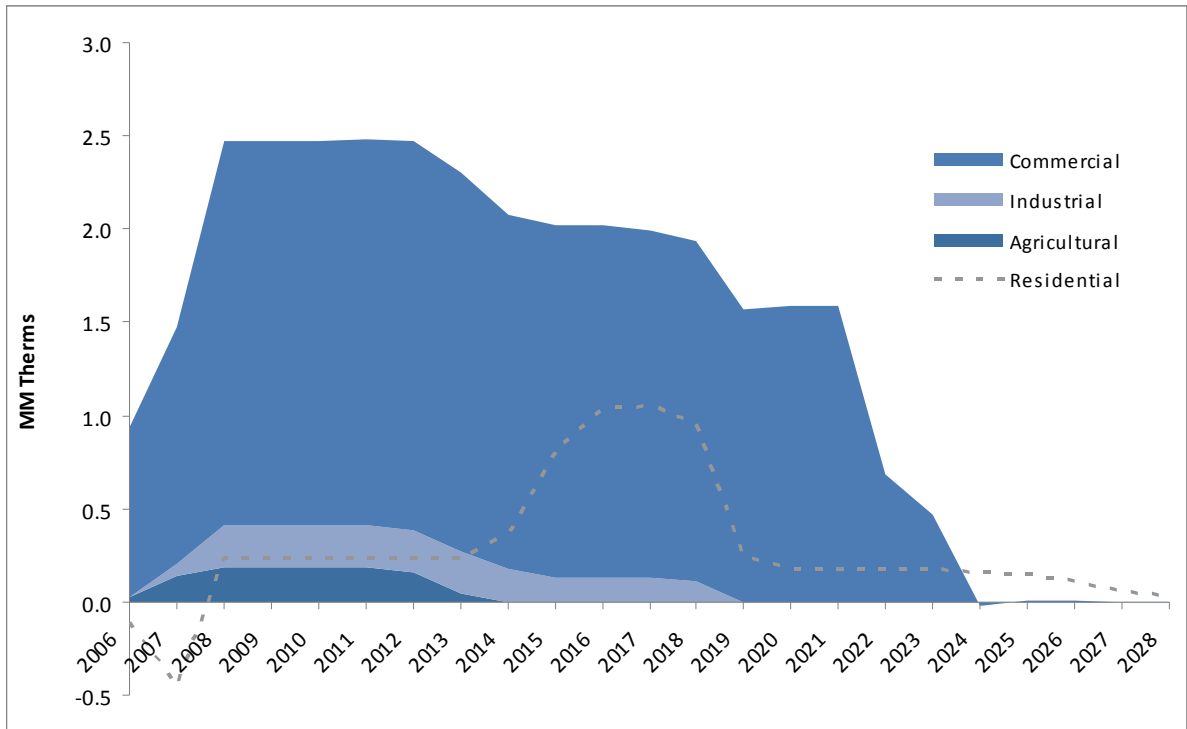
Figure 17 and Figure 18 illustrate the long-term impacts of these investments in electric and gas energy efficiency for the next 20 years.

<sup>20</sup> The error bound on the net evaluated savings are ±7.7% for GWh, ±6.1% for MW and ±5.9% for natural gas; details about the methodology are presented in section 4 of this report.

**Figure 17. SDGE Lifecycle Evaluated Savings -Electric**



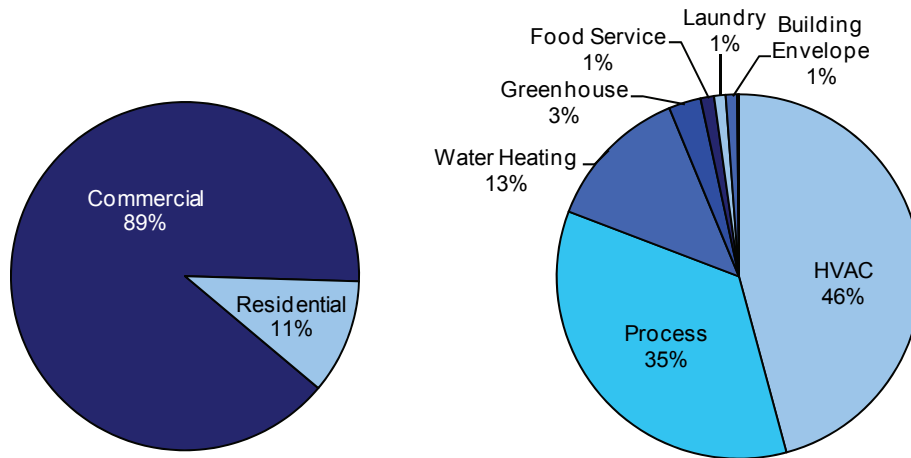
**Figure 18. SDGE Lifecycle Evaluated Savings -Gas**



**ES 7.4. Southern California Gas**

In the 2006-2008 program cycle SCG’s natural gas savings impacts were found in the residential and commercial sectors and achieved through the installation of a variety of measures. The majority of savings was achieved in the commercial sector and came from HVAC and process measures.

**Figure 19. SCG Natural Gas Savings by Market Distribution and Technology Type**



**Table 11. SCG Savings Impacts**

2006-2008	Annual Impacts <sup>21</sup>		Lifecycle Impact		% sales Gross
	Gross	Net	Gross	Net	
<b>Reported Savings</b>					
MMTherm	75	67	1,094	975	1.4%
<b>Evaluated Savings</b>					
MMTherm	54	32	574	344	1.0%
<b>Goal</b>					
MMTherm		57	<i>No Lifecycle Goals</i>		1.1%
<b>Emissions</b>					
<b>Tons of CO<sub>2</sub> Avoided</b>	319,344	171,916	3,438,345	207,558	

<sup>21</sup> The error bound on the net evaluated savings are ±14.6% for natural gas; details about the methodology are presented in section 4 of this report.



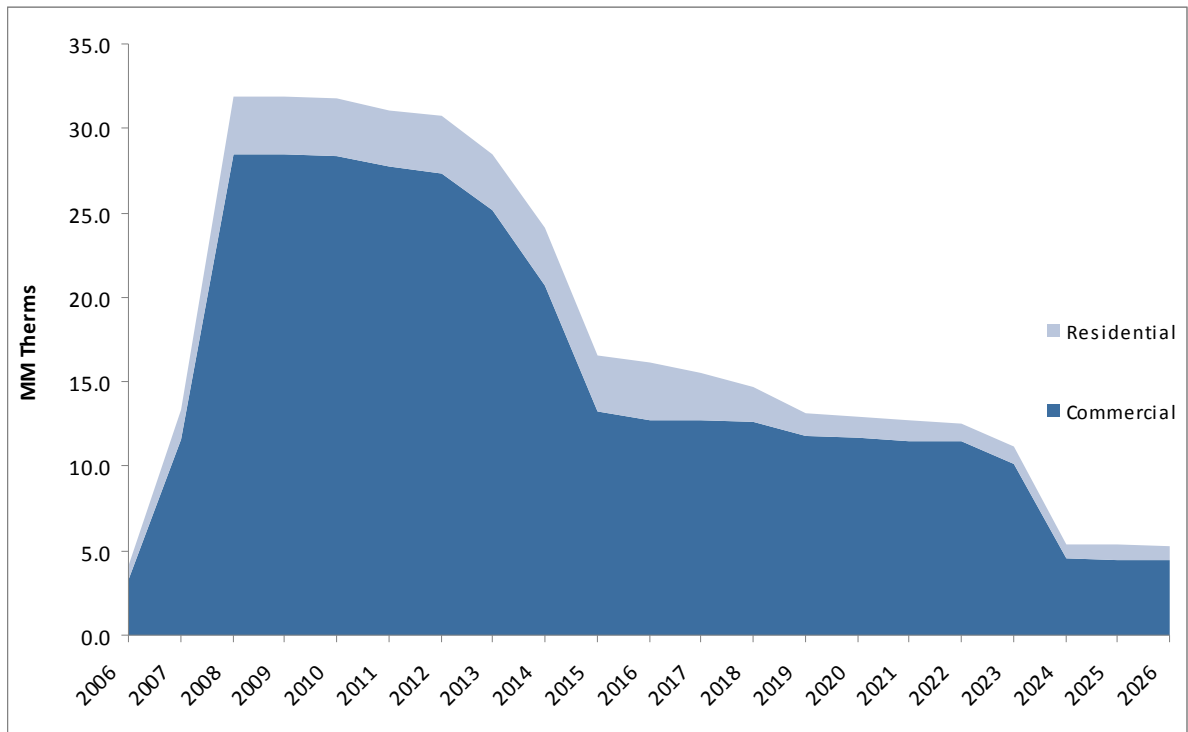
SCG did not meet the TRC test but did meet the PAC tests based on evaluated savings. In contrast, as calculated with SCG’s reported savings, the estimated TRC and PAC were 2.28 and 3.95 respectively.

**Table 12. SCG TRC / PAC**

	Benefits	Costs	Ratio
<b>Total Resource Cost Test (TRC)</b>	\$184	\$205	0.90
<b>Program Administrator Cost Test (PAC)</b>	\$184	\$116	1.59

Figure 20 illustrates the long-term impacts of these investments in gas energy efficiency for the next 20 years.

**Figure 20. SCG Lifecycle Evaluated Savings -Gas**



## **ES 8. Roadmap of the 2006-2008 Evaluation Report**

This report is organized as follows:

- Section 1 presents a brief introduction to the Commission’s Energy Efficiency and Evaluation Management and Policy and the framework of the evaluation of the 2006-2008 program cycle. It also provides a brief history of the 2006-2008 program evaluation cycle
- Section 2 reviews the findings from the Resource and Non-Resource Impact Evaluation Reports that were finalized in February 2010 and form the foundation for the evaluated energy savings for the 2006-2008 program cycle.
- Section 3 describes the methodology used to calculate the evaluated energy savings and benefits from the 2006-2008 energy efficiency programs.
- Section 4 presents the evaluated energy savings at statewide, portfolio, market sector and program levels for the 2006-2008 program cycle. It includes results from an analysis of the portfolio level confidence intervals, as well as comparison of achievements versus the Commission adopted goals.
- Section 5 presents the lifecycle stream of impacts from the 2006-2008 program cycle through 2028.
- Section 6 presents the estimated greenhouse gas emissions reductions achieved at statewide, and portfolio levels by the 2006-2008 energy efficiency programs.
- Section 7 presents the methodology used to estimate cost-effectiveness, and the cost-effectiveness at statewide, portfolio and portfolio levels, of the 2006-2008 program cycle.
- Section 8 presents the major accomplishments in the 2006-2008 evaluation cycle.
- Section 9 presents recommendations for future evaluations and programs.