California Public Utilities Commission

2006-2008 Energy Efficiency Evaluation Report

July 2010

Prepared by Energy Division

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EXECUTIVE SUMMARY

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[1] 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,[2] which are based on assumptions developed prior to the implementation of the 2006-2008 program cycle.

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

[2] Utility-reported savings estimates are posted on the Commission's Energy Efficiency Groupware Application (EEGA) website 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.[3] The energy savings impacts also resulted in over 4 million tons of avoided CO_2 emissions; the equivalent of 760,456 cars being removed from California's roads.[4]

Table 1. Savings Impacts from 2006-2008 IOU Energy Efficiency Investments[5]

	Annual Impact		Lifecycle Impact		% of 2008 IOU sales
	Gross	Net	Gross	Net	Gross
GWh	6,497	4,097	66,142	42,736	3.2%
MW	1,175	779			
MMTherm	84	44	1,379	690	1.0%
Tons of CO2	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;

[3] 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.

[4] In estimating CO2 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_2).

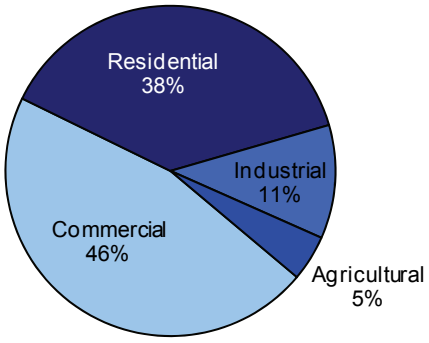
[5] Gross savings represent the total savings resulting from the program activities, regardless of the attribution, or responsibility for achieving those savings. Net savings represent the portion of total (gross) savings that are directly attributable to the IOUs' program activities, after taking out 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



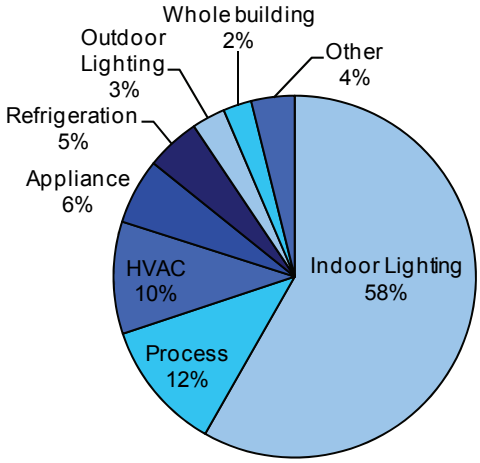
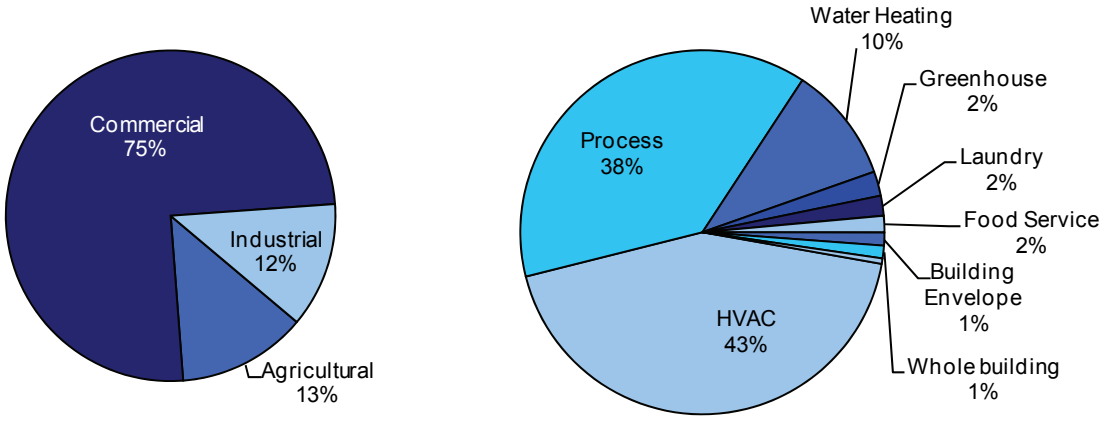
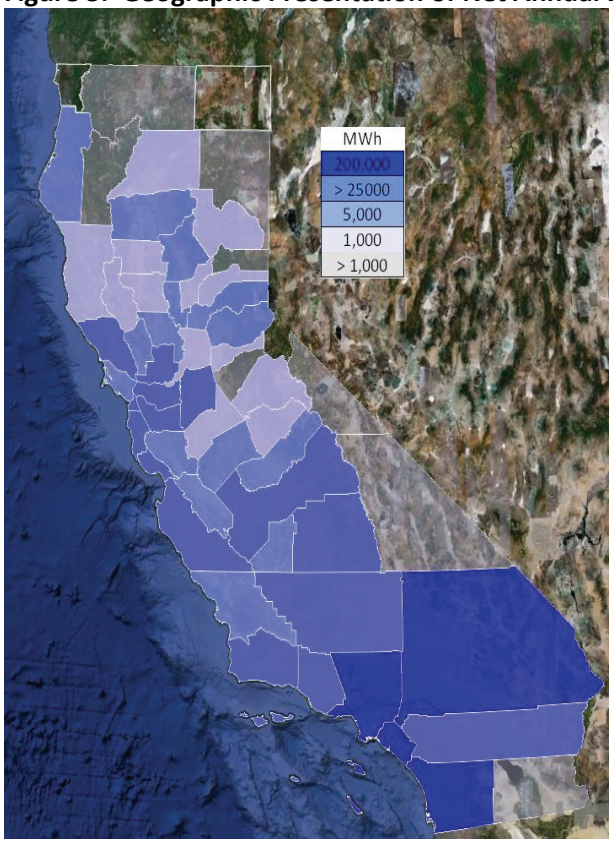


Figure 2. Natural Gas (MMTherm) Savings by Market Distribution and Technology Type



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.

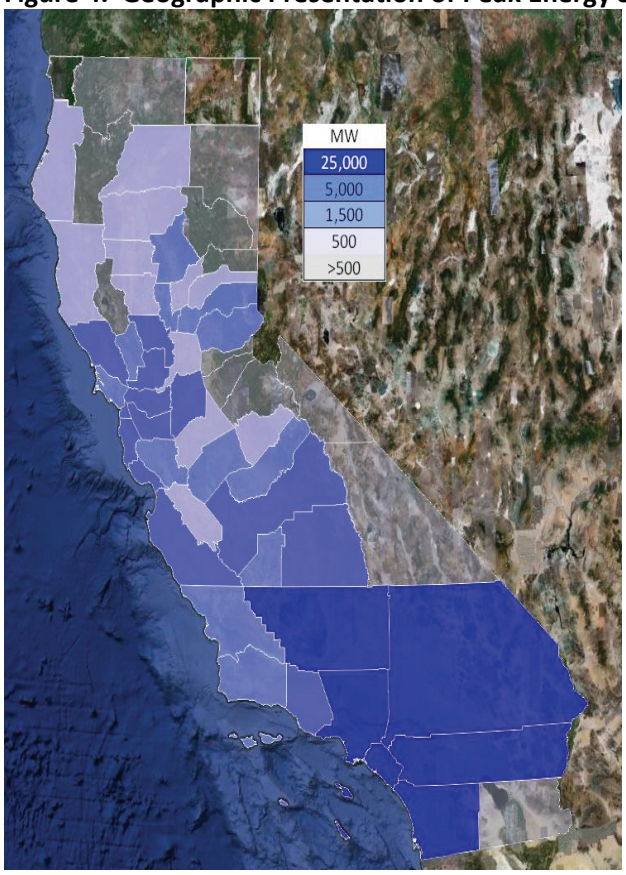
Figure 3. Geographic Presentation of Net Annual Electric Energy Savings Statewide



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

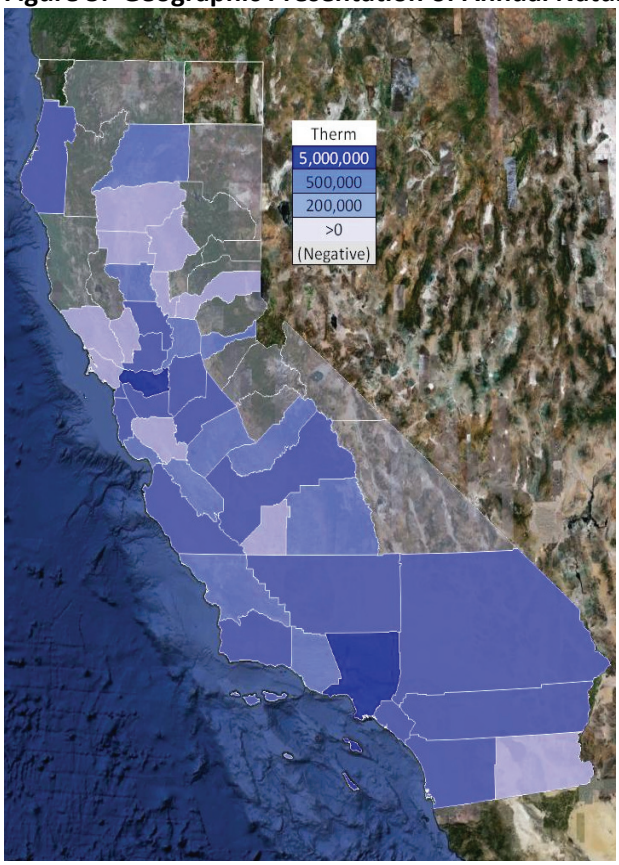


County	kW Savings
LOS ANGELES	99,021
ORANGE	56,318
SAN BERNARDINO	54,201
SAN DIEGO	53,665
RIVERSIDE	37,739
KERN	25,969
ALAMEDA	24,556
FRESNO	21,291
SANTA CLARA	18,743
SAN JOAQUIN	18,171
CONTRA COSTA	15,426
TULARE	15,208
VENTURA	13,372
SAN FRANCISCO	11,809
SAN MATEO	7,147
SOLANO	6,790
YOLO	6,358
SONOMA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



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

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

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

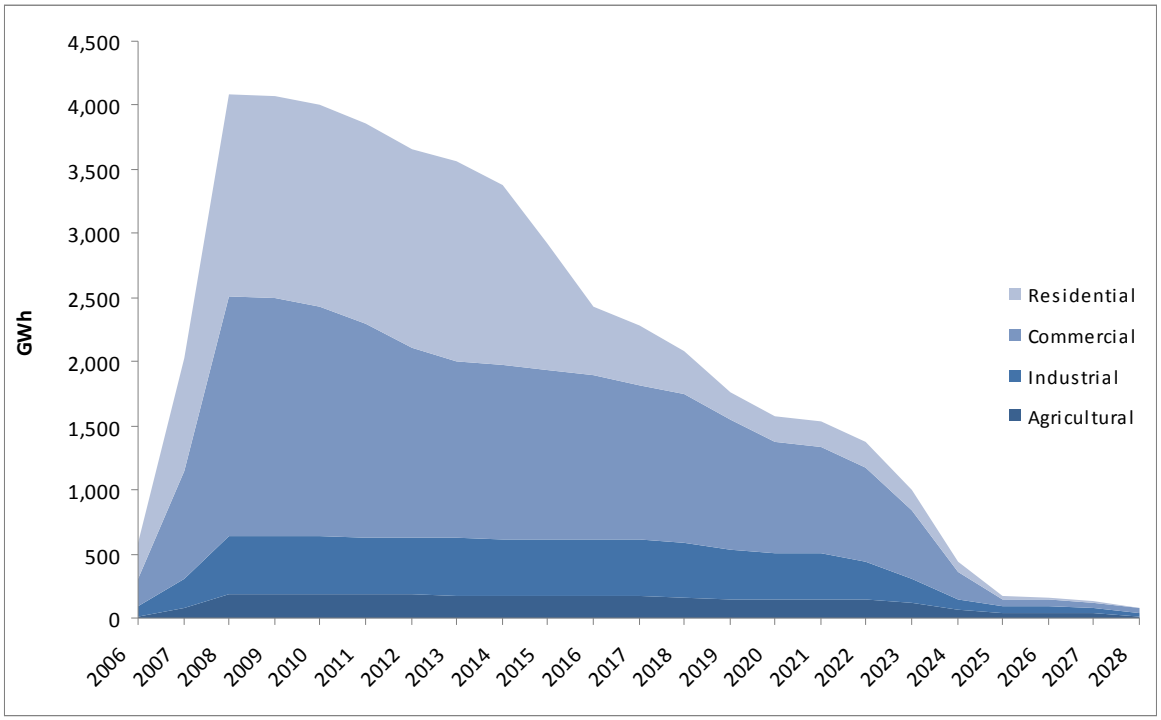
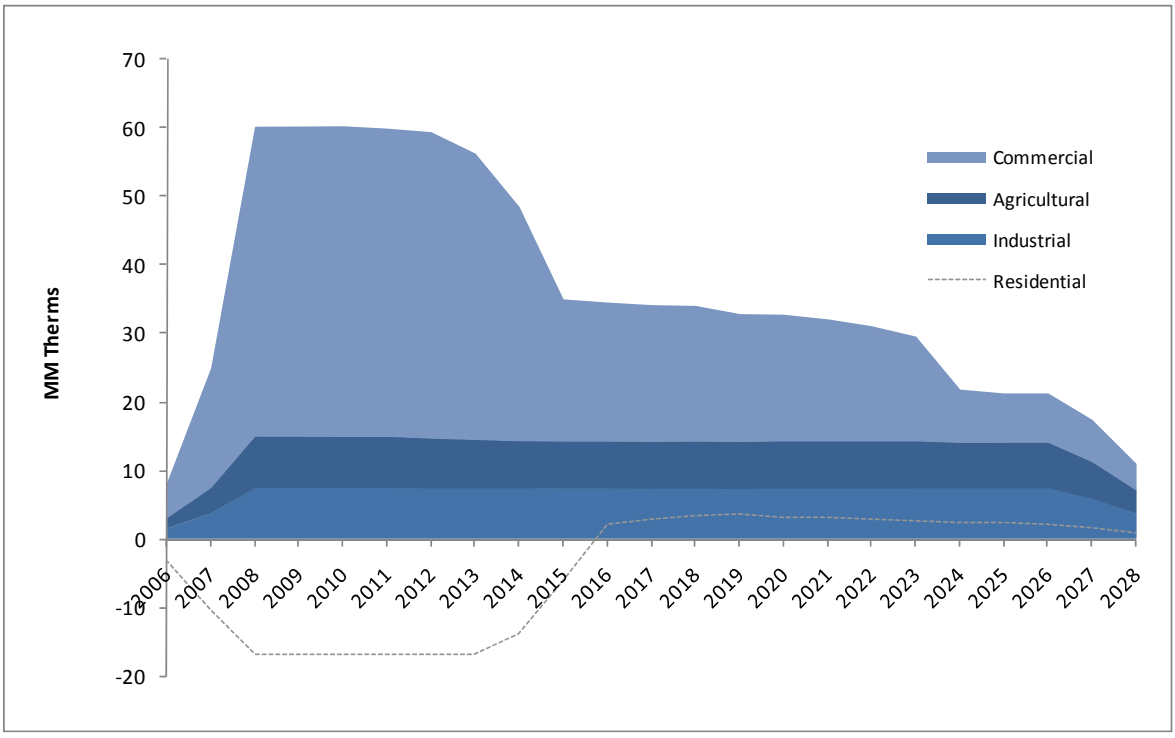


Figure 7. Lifecycle Evaluated Savings- Gas



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.[6] 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.

[6] 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.[7] 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.[8] 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

[7] 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 .

[8] 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:[9]

- 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.

[9] 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*

	kWh		kW		Therms	
Program Cycle	**Reported**	**Evaluated**	**Reported**	**Evaluated**	**Reported**	**Evaluated**
2002-2003	118%	104%	104%	86%	98%	81%
2004-2005	127%	79%	133%	75%	182%	55%
2006-2008	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[10] 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.

[10] Available at 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[11] 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.[12]

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
Content	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
Purpose	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
Timeline	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.

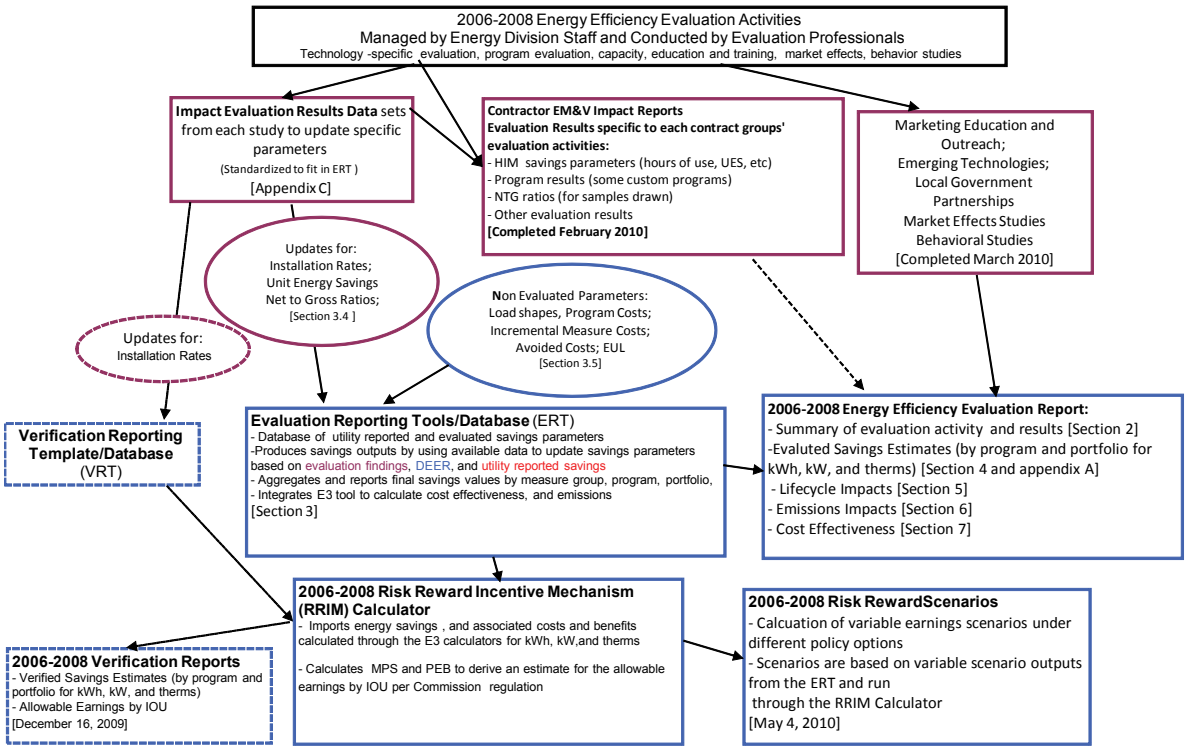
[11] See "Administrative Law Judge's Ruling Adopting Protocols for Process and Review of Post-2005 Evaluation, Measurement and Verification (EM&V) Activities, available at http://docs.cpuc.ca.gov/PUBLISHED/RULINGS/52676.htm .

[12] See Decisions 07-09-043 and 08-01-042, at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/73172.PDF and 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.[13]

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[14]. Energy Division required the evaluation contractors to submit

[13] See www.calmac.org .

[14] 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).[15]

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. [16]

[15] See footnote 12 for background on the RRIM report.

[16] 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
Resource			
New Construction/ Codes & Standards	Ayat Osman	KEMA	$7.0 million
HIM: Whole Building			
Residential Retrofit/Upstream Lighting	Mikhail Haramati	Cadmus	$18.7 million
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			
Commercial Retro-commissioning	Jeorge Tagnipes	SBW	$3.2 million
HIM: Retro-commissioning			
Local Government Partnerships	Jeorge Tagnipes	Summit Blue	$7.9 million
Major Commercial	Jeorge Tagnipes	SBW	$4.9 million
HIM: On-site Audit, custom lighting, custom HVAC, custom other			
Small Commercial	Jeorge Tagnipes	Itron	$8.9 million
HIM: high-bay fluorescent			
Specialized Commercial	Jeorge Tagnipes	KEMA	$4.6 million
HIM: Refrigerant Charge Airflow, AC replacement, Duct Sealing			
Commercial Facilities	Kay Hardy	ADM	$3.2 million
HIM: Refrigeration Door Gasket and Strip Curtains			
PG&E Agricultural & Food Processing	Kay Hardy	KEMA	$1.7 million
HIM: Greenhouse Heat Curtains and IR Film			
PG&E Fabrication, Process & Manuf.	Kay Hardy	Itron	$4.3 million
HIM: Pump-off controllers			
SCE Industrial & Agriculture	Kay Hardy	Itron	$4.4 million
HIM: Pump tests, Steam Traps, Pipe Insulation			
Non-Resource			
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
Market Effects Studies			
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.[17] 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.

[17] 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

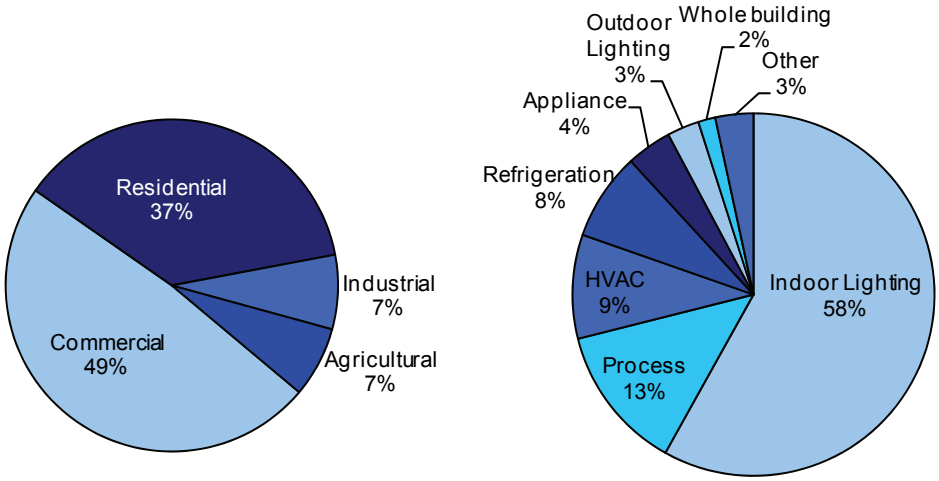


Figure 10. PGE Natural Gas Savings by Market Distribution and Technology Type

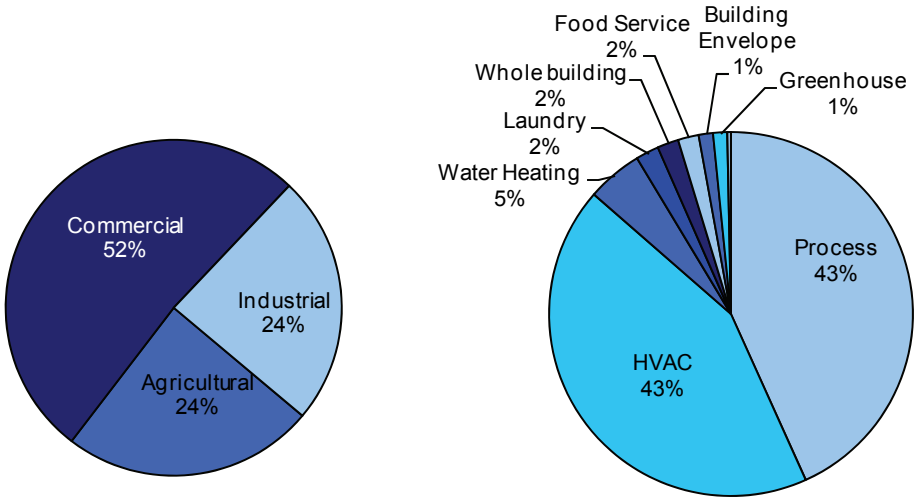


Table 5. PGE Savings Impacts

2006-2008	Annual Impacts[18]		Lifecycle Impact		% of 2008 sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
GWh	6,292	5,251	57,486	46,603	7%
MW	994	845			
MMTherm	83	66	1,404	1,091	3%
Evaluated Savings					
GWh	2,999	1,766	30,315	18,537	3%
MW	513	320			
MMTherm	47	22	918	411	2%
2006-2008 Program Cycle Goal					
GWh		2,826			3%
MW		613	*No lifecycle goals*		
MMTherm		45			2%
Emissions Reductions					
Tons of CO_2 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
Total Resource Cost Test (TRC)	$1,253	$1,069	1.17
Program Administrator Cost Test (PAC)	$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.

[18] 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

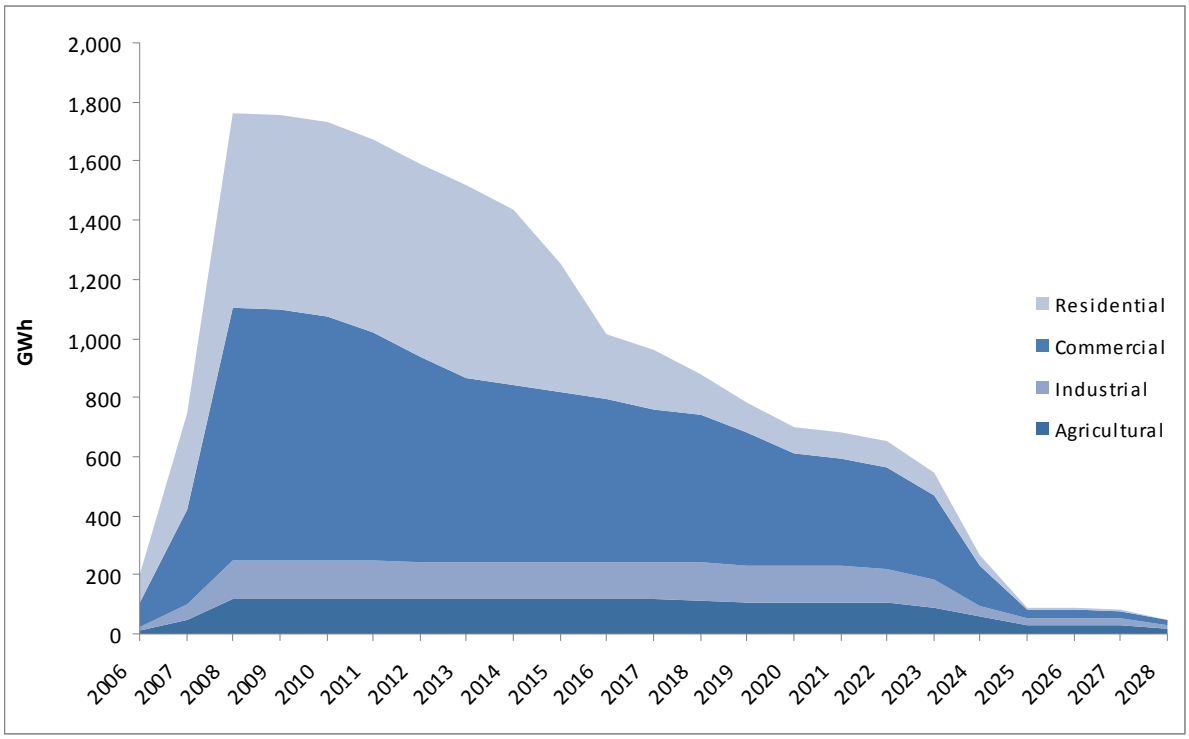
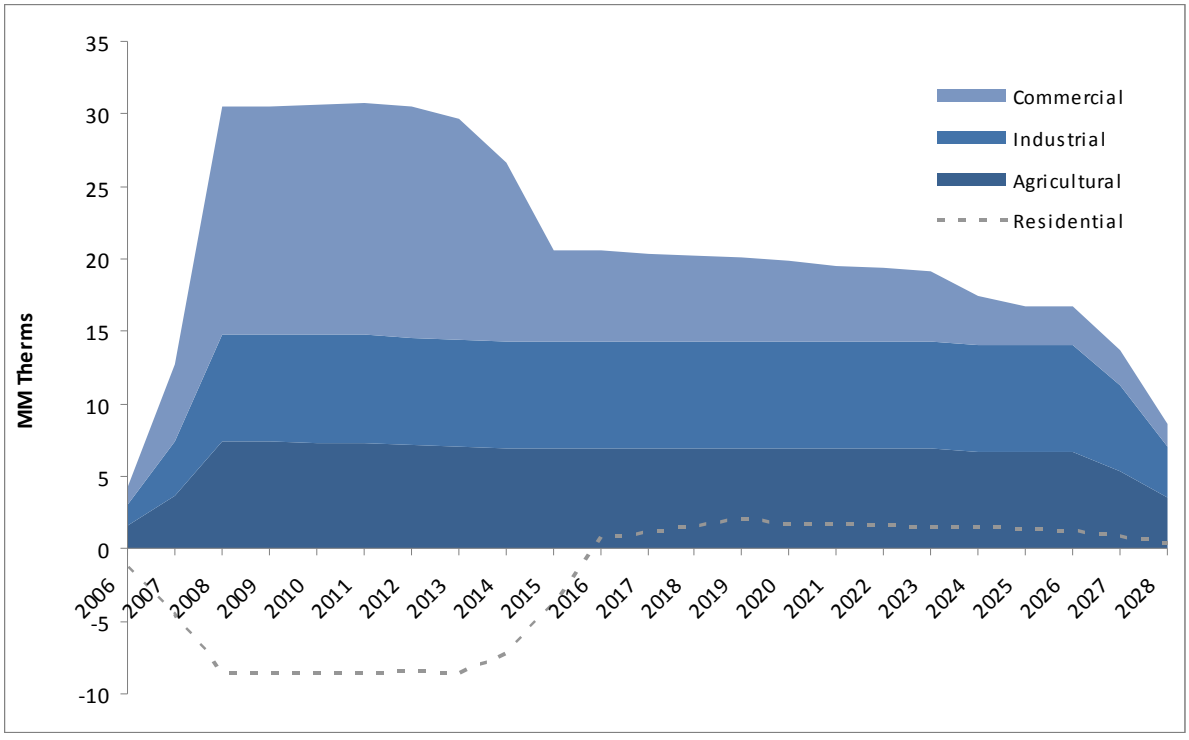


Figure 12. PGE Lifecycle Evaluated Savings -Gas



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

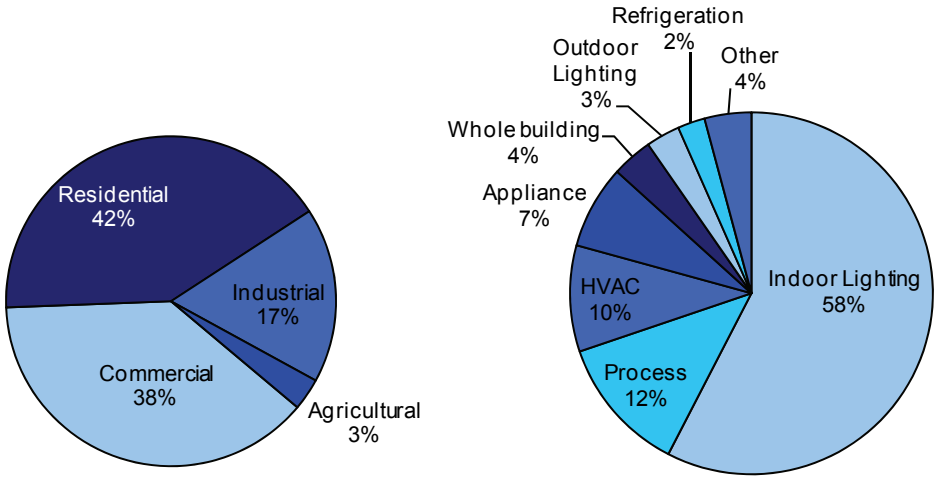


Table 7. SCE Savings Impacts

2006-2008	Annual Impacts[19]		Lifecycle Impact		% of 2008 sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
GWh	5,100	3,898	46,769	35,506	5%
MW	885	690			
Evaluated Savings					
GWh	2,936	1,963	29,719	20,029	3%
MW	551	384			
2006-2008 Program Cycle Goal					
GWh		3,135	*No Lifecycle Goals*		3%
MW		672			
Emissions					
Tons of CO_2 Avoided	1,553,567	1,046,414	15,992,515	11,372,622	

[19] 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.

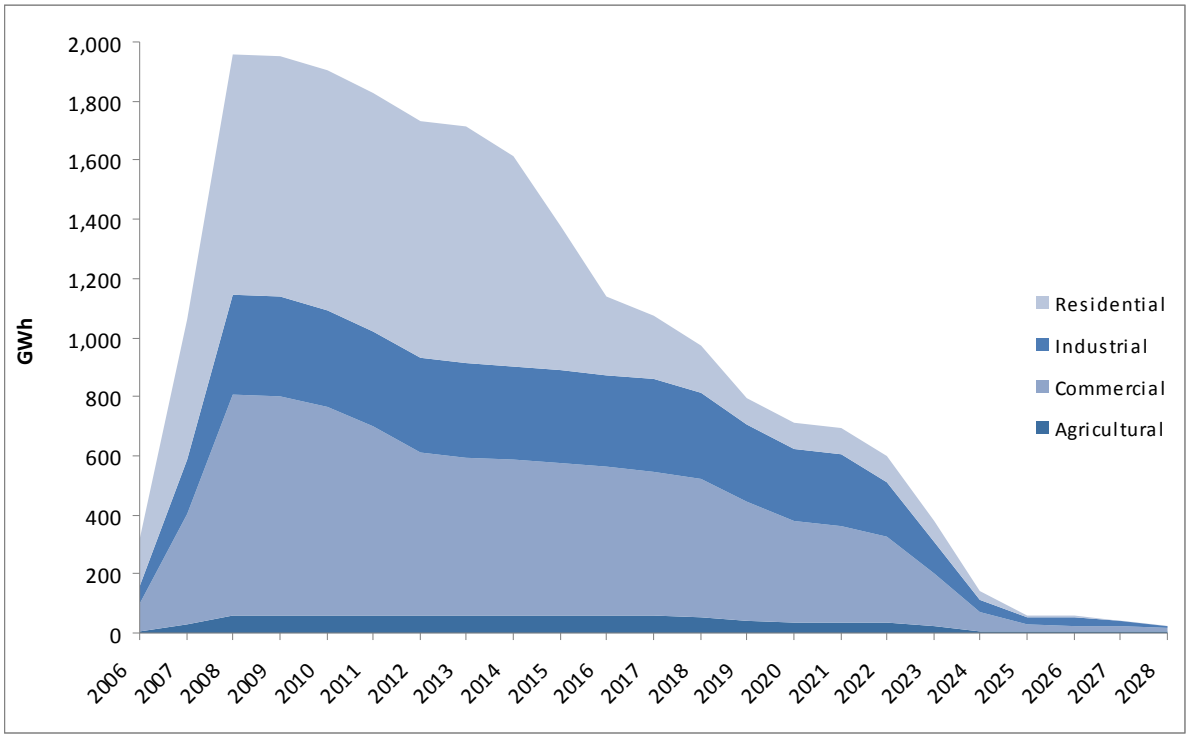
SCE met the cost effectiveness threshold based on evaluated savings. As calculated with SCE's reported savings, their TRC and PAC were 2.26 and 3.52 respectively.

Table 8. SCE TRC / PAC

	Benefits	Costs	Ratio
Total Resource Cost Test (TRC)	$1,169	$984	1.19
Program Administrator Cost Test (PAC)	$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

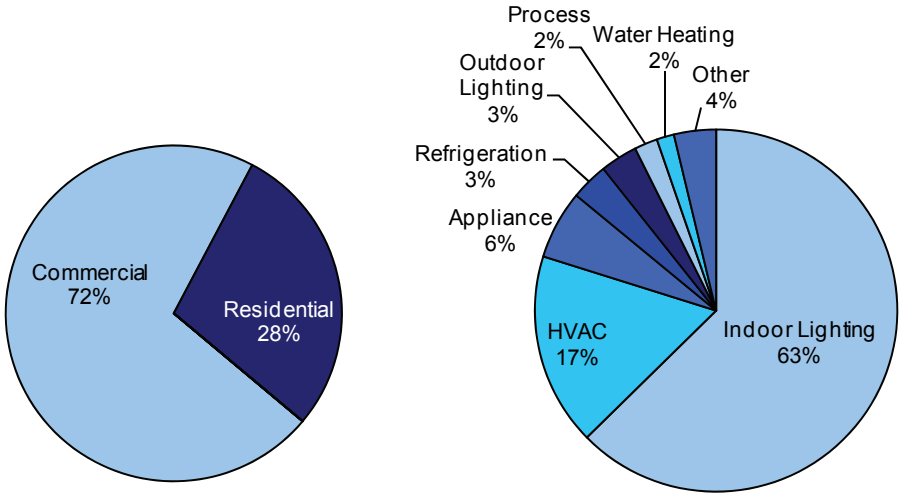


Figure 16. SDGE Natural Gas Savings by Market Distribution and Technology Type

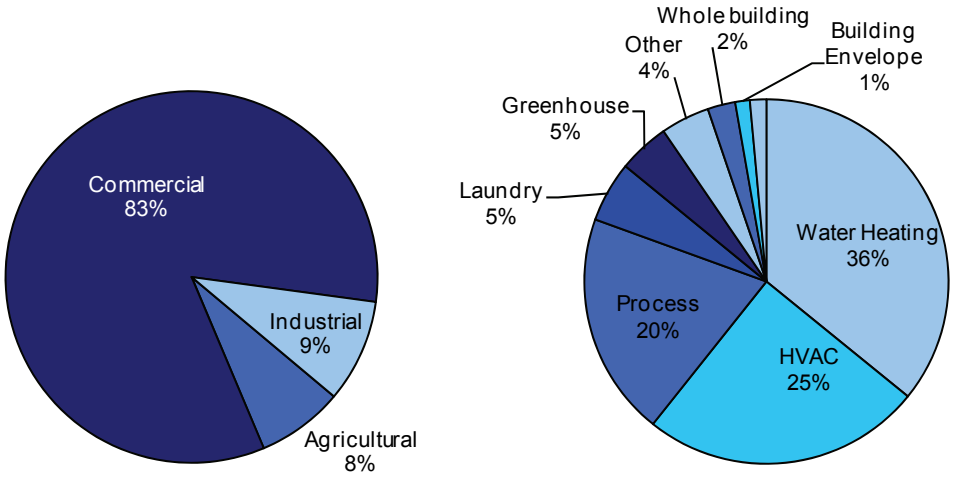


Table 9. SDGE Savings Impacts

2006-2008	Annual Impacts[20]		Lifecycle Impact		% of sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
GWh	1,035	850	10,418	8,494	8%
MW	175	147			
MMTherm	8	7	103	86	1.1%
Evaluated Savings					
GWh	554	364	5,967	4,100	4%
MW	106	72			
MMTherm	3.3	2.7	51	37	0.46%
Goal					
GWh		638			5%
MW		122	*No lifecycle goals*		
MMTherm		10			1.4%
Emissions					
Tons of CO_2 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
Total Resource Cost Test (TRC)	$281	$276	1.02
Program Administrator Cost Test (PAC)	$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.

[20] 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

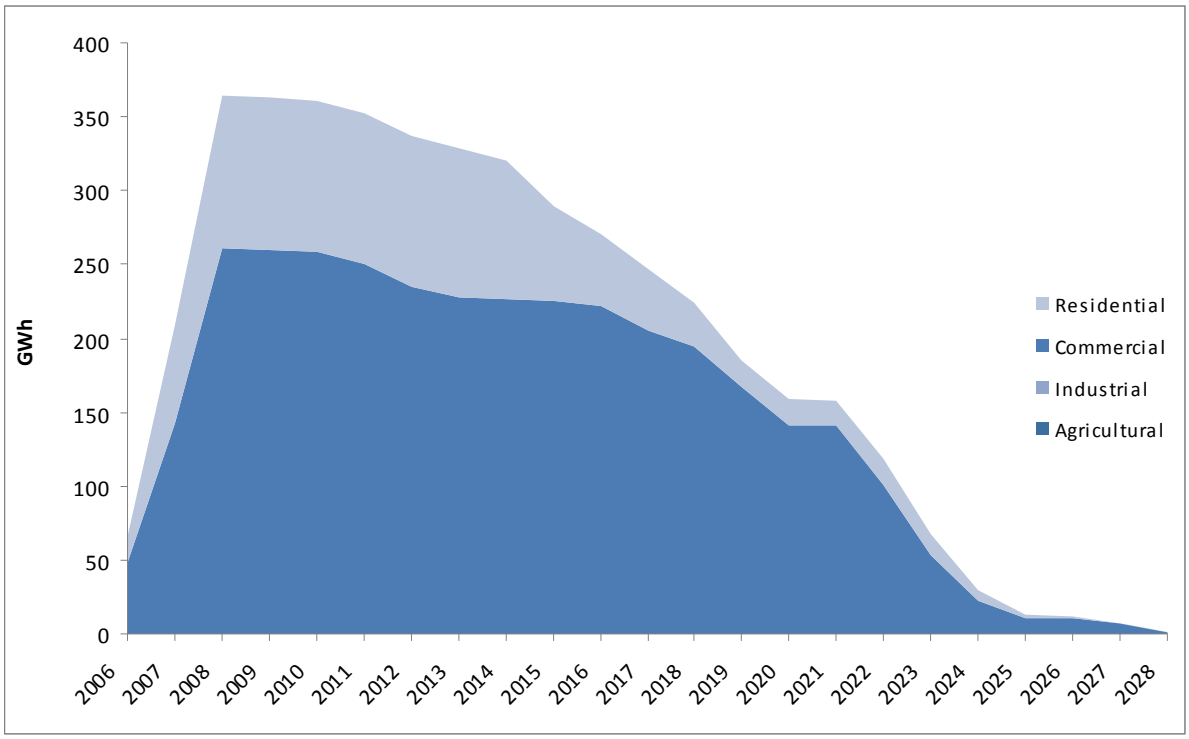
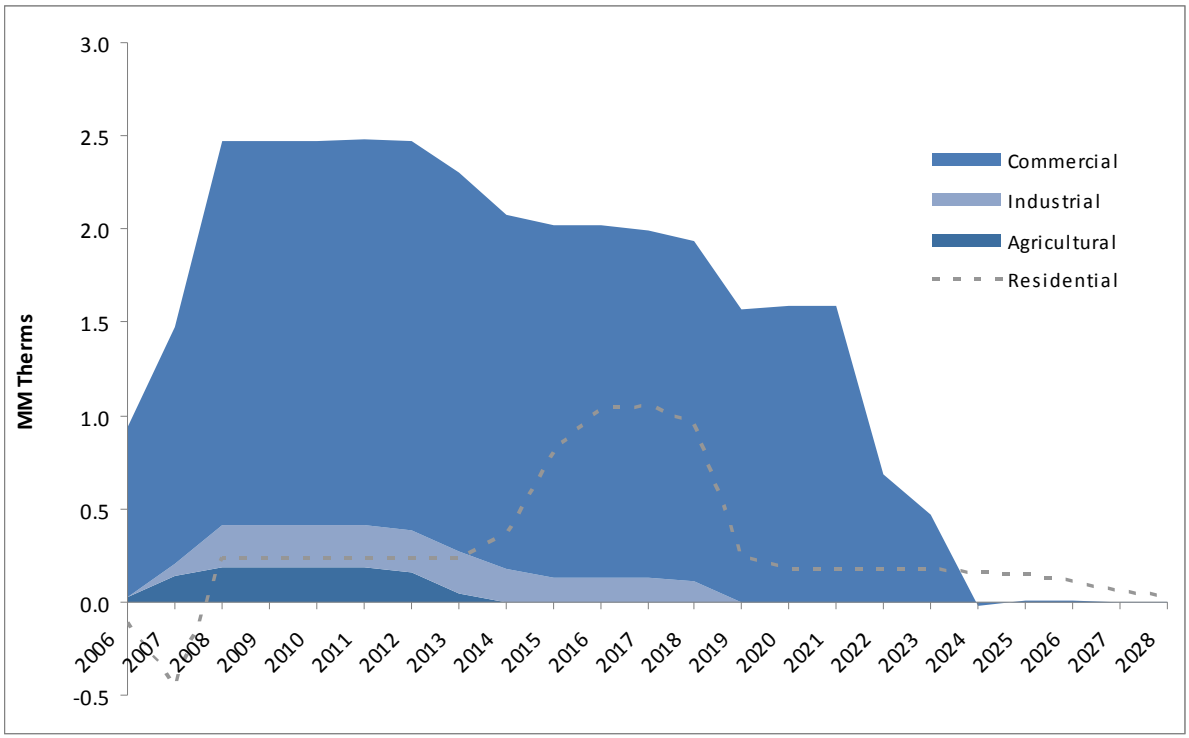


Figure 18. SDGE Lifecycle Evaluated Savings -Gas



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

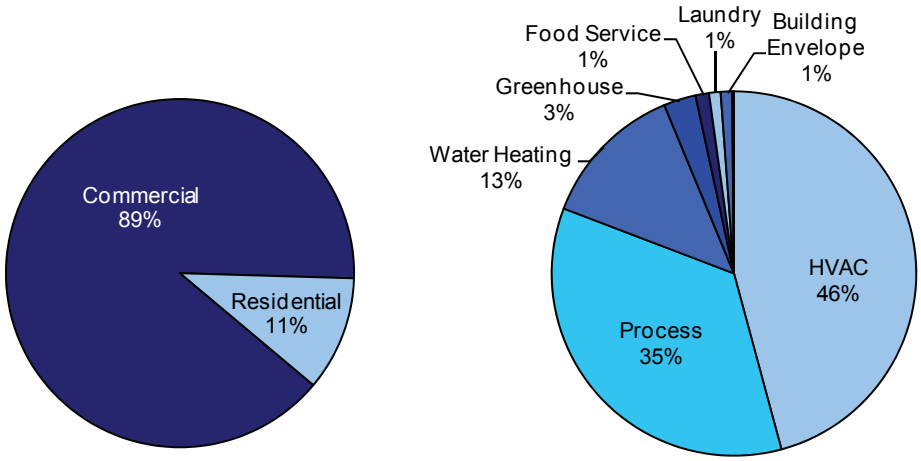


Table 11. SCG Savings Impacts

2006-2008	Annual Impacts[21]		Lifecycle Impact		% sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
MMTherm	75	67	1,094	975	1.4%
Evaluated Savings					
MMTherm	54	32	574	344	1.0%
Goal					
MMTherm		57	*No Lifecycle Goals*		1.1%
Emissions					
Tons of CO_2 Avoided	319,344	171,916	3,438,345	207,558	

[21] 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.

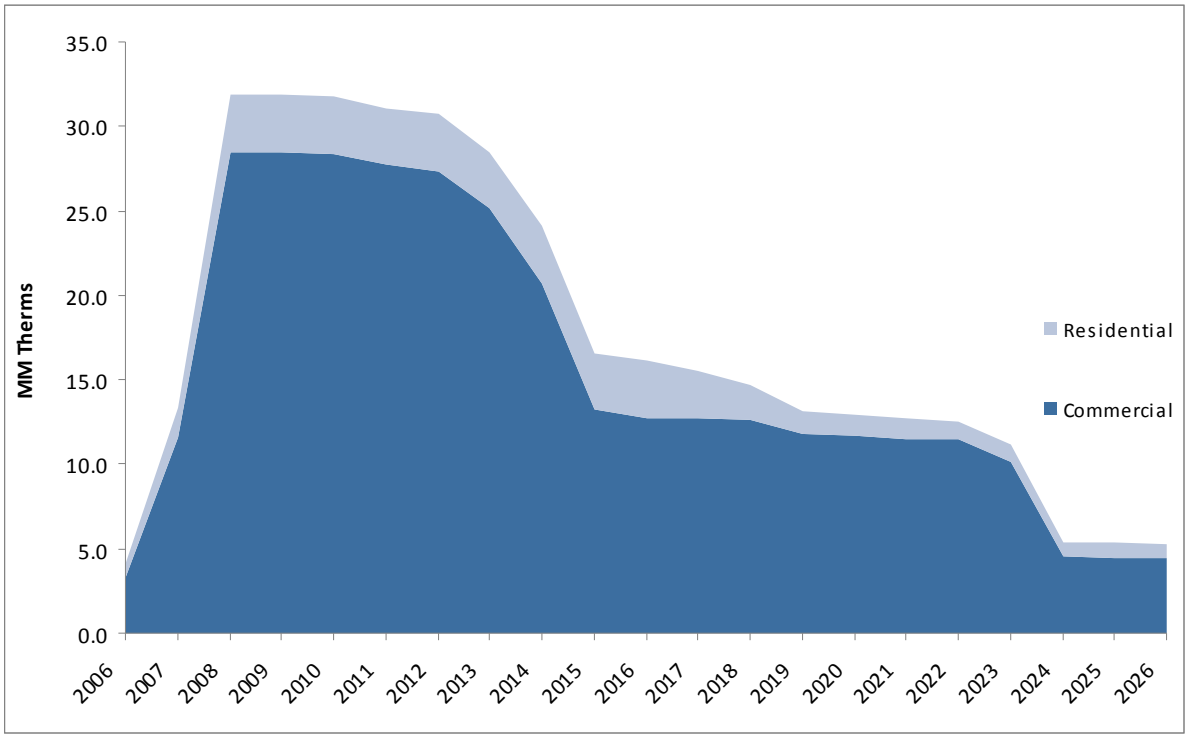
SCG did not meet the TRC test but did meet the PAC tests based on evaluated savings. In contrast, as calculated with SCG's reported savings, the estimated TRC and PAC were 2.28 and 3.95 respectively.

Table 12. SCG TRC / PAC

	Benefits	Costs	Ratio
Total Resource Cost Test (TRC)	$184	$205	0.90
Program Administrator Cost Test (PAC)	$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.

1. INTRODUCTION TO EVALUATION MANAGEMENT AND POLICY

The Energy Division's evaluations of the 2006-2008 energy efficiency programs implemented by California's four largest utilities were guided by specific policies and decisions issued by the California Public Utilities Commission (CPUC or Commission) to meet multiple policy objectives. The policies and prescriptive procedures established by the Commission influenced the management of the evaluations as well as the outcomes that are included in this report and are therefore presented here to allow readers to understand the proper context of the results.

1.1. Commission Policy and Procedural Background for 2006-2008 Evaluation

In 2003, the CPUC, in collaboration with the California Energy Commission (CEC) and the Consumer Power and Conservation Financing Authority (no longer in existence) issued the first Energy Action Plan (EAP). The plan, developed in response to a crisis in California's energy markets, represented a high-level, coherent approach to meeting California's energy and natural gas needs. Significantly, the initial EAP set forth a loading order to define future efforts to meet California's energy needs.[22] The loading order stipulated that the state would invest first in energy efficiency and demand-side resources. The EAP is a "living" document, and there have been two subsequent plans issued in the past five years.

In January 2005,[23] the CPUC adopted an administrative structure for post-2005 energy efficiency programs designed to meet the objectives of the Energy Action Plan adopted in 2003, and the savings reflected in the energy savings goals adopted in September 2004.[24] The long term savings goals were developed from analysis of technical and economic potential conducted in 2002-2004, and were deliberately set as "stretch goals". For the 2006-2008 and future program cycles, the adopted structure returned to the utilities the functions of selecting the activities and implementers for the portfolio of energy efficiency programs (this function is referred to as program choice) and the daily tasks associated with administering and coordinating program activities during funding cycles (this function is referred to as portfolio management), a role the utilities had previously fulfilled from 1990-1997 prior to electric industry restructuring.

In addition to providing program oversight, the Commission gave Energy Division the responsibility for managing and contracting for all evaluation, measurement and verification (EM&V) studies to:

- Measure and verify energy and peak load savings for individual programs, groups of programs and at the portfolio level;
- Generate the data for savings estimates and cost-effectiveness inputs;

[22] "Energy Action Plan I", California Energy Commission, California Public Utilities Commission and Consumer Power and Conservation Financing Authority. May 8, 2003. Available at: http://docs.cpuc.ca.gov/word_pdf/REPORT/28715.pdf

[23] D.05-01-055, available at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/43628.PDF .

[24] D.04-09-060, available at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/40212.PDF .

- Measure and evaluate achievements of energy efficiency programs, groups of programs and/or the portfolio terms of the "performance basis" established under the CPUC-adopted EM&V protocols;[25]

- Evaluate whether program or portfolio goals are met.

The Commission replaced the design of previous program cycles, which occurred either annually or, in the case of the 2004-2005 cycle, over the course of two years, with a three-year program cycle to encourage longer term planning. The Commission also directed that utility energy efficiency performance be evaluated based on overall portfolio energy savings achievements, rather than on the performance of each individual program, in order to "encourage innovation, and allow for some risk-taking on pilot programs and/or measures in the portfolio."[26]

In April 2005, the Commission augmented its January 2005 decision and established the policies and administrative framework that would guide future energy efficiency program cycles. Of particular importance were updates to the Rules in the Energy Efficiency Policy Manual to reflect Commission objectives for energy efficiency. The explicit policy rules guiding the 2006-2008 implementation and evaluation and the definition of savings specified that savings would only be counted for technologies that were installed and operable at the time of the evaluation; commitments to install a technology were not to be counted in determining total savings. The policy rules also defined the net to gross ratio as being net of free-riders, and did not include savings impacts from spillover or any other market effects that may have been generated by the programs.[27]

The updated administrative framework and policy rules provided guidance for program administrators, program implementers and interested parties for the development of program portfolios for 2006 and beyond. In addition, the Commission adopted Evaluation, Measurement and Verification (EM&V) protocols in collaboration with stakeholders.

The Commission also established the performance basis metric for evaluating the performance of energy efficiency programs designed to displace more costly supply-side energy resources. The performance basis is calculated based on net resource benefits (evaluated energy savings benefits minus costs) produced by the program(s). [28]

The evaluated savings were intended to be the foundation for determining allowable earnings under the risk reward incentive mechanism (RRIM) that was adopted by the Commission in 2007.[29] A

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[25] The California Energy Efficiency Evaluation Protocols are guidance tools policymakers use to plan and structure evaluation efforts and that staff of the California Public Utilities Commission's Energy Division (CPUC-ED) and the California Energy Commission (CEC) (collectively the Joint Staff), and the portfolio (or program) administrators (Administrators) use to plan and oversee the completion of evaluation efforts. The Protocols are also guidance documents for the design and evaluation of programs implemented after December 31, 2005. The Protocols are available at http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/ .

[26] D.05-04-051, available at: http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/45783.PDF .

[27] See "Energy Efficiency Policy Manual v. 4" at http://www.cpuc.ca.gov/NR/rdonlyres/F17E8579-3409-4089-8DE4-799832CF682E/0/PolicyRulesV4Final.doc, as adopted in D.05-04-051.

[28] D. 05-04-051.

[29] see D.07-09-043 at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/73172.PDF .

separate document will be produced by Energy Division to inform the final true up of incentives in the RRIM proceeding.[30]

1.2. Chronology of the 2006-2008 Evaluation

In September 2005,[31] the Commission authorized IOU energy efficiency portfolio plans and initial funding levels for the 2006-2008 program cycle. These portfolio plans reflected a mix of program designs and implementation strategies in combination with approaches to solicit new, innovative designs and savings technologies to enhance overall portfolio performance in both the short- and long-term. Funding for the programs is collected via a surcharge that IOU customers pay based on their electricity and natural gas consumption. The Commission authorized $1.97 billion in funding to be used by the four IOUs to implement their energy efficiency programs over the three-year cycle. Mid-cycle program funding requests approved by the Commission and Evaluation, Measurement and Verification (EM&V) funding for evaluation and related projects brought the final 2006-2008 budget to $2.21 billion.[32]

The 2006-2008 programs were projected to produce energy savings of approximately 1,685 MW, 7,367 GWh, and 127 MMTherms and surpass the Commission's adopted goals for the program cycle.[33] The initial estimates of savings used to inform the design and approval of the 2006-2008 portfolio of programs were based on historic accomplishment, past evaluation results, deemed estimates from DEER[34], and work papers filed by the utilities. The estimates represented the best available data for any given technology or program design at the time, and to meet the annual and cumulative CPUC goals set for the program cycle.

Once approved, the programs began operation, and the IOUs reported the savings to the CPUC via the EEGA[35] website monthly, quarterly and annually until the completion of the program cycle. The reported savings were based on the same savings assumptions used in planning the portfolio, with some exceptions. Over the course of the 2006-2008 program implementation cycle, most of the

[30] 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.

[31] D.05-09-043, available at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/49859.PDF .

[32] The Commission authorized additional funding of $162.8 million for EM&V activities to be conducted by CPUC staff and the IOUs over the 2006-2008 program cycle in D.05-11-011. The Commission also authorized $87.3 million in additional program funding for PGE and SCE in D.06-12-013, D.08-10-027, and Resolution G-3421. Note that for the 2006-2008 program cycle, the Commission approved fund-shifting rules that afforded the IOUs greater latitude in allocating funds among budget categories within programs, among programs within a category, and among categories, creating the potential for program budgets at the end of the program cycle that differed from those initially authorized in 2005.

[33] MW = Megawatt; GWh = Gigawatt hour; MMTherms = Millions of therms. See Decision 05-09-043 for a comparison of projected savings and Commission goals for the 2006-2008 program cycle http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/49859.PDF .

[34] DEER is the "Database for Energy Efficiency Resources". DEER contains information on selected energy-efficient technologies and measures. The DEER provides estimates of the energy-savings potential for these technologies in residential and nonresidential applications. The database contains information on typical measures -- those commonly installed in the marketplace -- and data on the costs and benefits of more energy-efficient measures. See http://www.deeresources.com/ .

[35] EEGA is the "Energy Efficiency Groupware Application" and is accessible at www.eega2006.com .

energy savings were achieved in the last year of program implementation as a result of the slow ramp up of programs and the time needed to develop large projects.

Over the course of the program cycle, the reported savings estimates based on detailed program tracking data were used to design field evaluations to measure and verify these claims and to determine actual energy savings achieved during the program cycle. The fact that a majority of the savings occurred in the last year of the program cycle created particular challenges with respect to drawing representative samples early in the program cycle, and resulted in much of the field measurement occurring in 2009.

The CPUC and the IOUs have overseen evaluation, measurement and verification of accomplishments and program performance conducted by independent evaluation professionals since the inception of the energy efficiency programs in California. All parties recognize the value of conducting field-based evaluation, measurement and verification to understand savings occurring in the field and to inform updates to planning assumptions for savings expected from any given measure or program strategy. Field evaluation verifies that energy efficiency measures that were reported were actually installed and that the investments resulted in savings that would not have occurred absent program intervention. This "true-up" process adjusts the savings achievements reported by IOUs and results in the evaluated (actual post-installation) energy savings impacts.

Concurrent with the launch of the 2006-2008 programs, Energy Division staff initiated planning for the evaluation in August 2005. In late 2006, the Commission hired a team of consultants -- the Master Evaluation Contract Team (MECT) -- to assist Energy Division in prioritizing the evaluation work and procuring contractors to conduct impact evaluations and related studies for the 2006-2008 program cycle. The competitive bid process was initiated for sixteen contracts that were focused on specific market segments and collections of similar programs. Bidders were allowed to assemble teams across firms to enhance the expertise available to the Energy Division in conducting the evaluations.

In August 2007, through this competitive bid process, Energy Division hired evaluation consultants to conduct the evaluations in partnership with Energy Division contract managers and MECT advisors. Many of the winning firms demonstrated long-term expertise in evaluating California's energy efficiency program activities and had performed prior evaluation work for previous program cycles, when the IOUs were in charge of the evaluations.

The first task for the evaluation teams was to develop an evaluation plan that complied with the "Energy Efficiency Policy Manual v.3 and v.4" and the evaluation protocols adopted by the Commission. Energy Division staff and their MECT advisors reviewed and assessed evaluation plans to ensure that they aligned with the type of programs being implemented, and addressed key researchable issues. In December 2007 these evaluation plans were presented to the public for review and comment. In addition, plans for certain controversial aspects of the evaluation work, specifically net to gross analysis, were also open for public comment.

Several adjustments to the evaluation plans were made over the course of 2008 as the final results from the program implementations were reported by the IOUs. A significant portion of the savings was reported in this last year of the program cycle and the savings were found to be highly concentrated among particular measures. One of the significant adjustments made in mid-2008 was to allocate additional evaluation resources to those measures that made up greater than one percent of the kWh or therm energy savings for any given utility. These measures were dubbed

"high impact measures" (HIMs) and evaluation resources were channeled to contracts that either already had significant concentrations of these measures in the programs they were evaluating or had available capacity to focus on a particular measure. Samples were re-assessed and revised to ensure larger sample sizes for these measures regardless of the program in which they resided. This approach was also better aligned with the parameter-specific updates that were required by the ALJ Ruling issued in R.01-08-028 on January 11, 2006, which is discussed in section 1.3.

In early 2008, as the evaluations got underway, Energy Division hired a Data Management and Quality Control (DMQC) team. The DMQC served as technical advisors to assist Energy Division staff and MECT advisors in their oversight of the 2006-2008 EM&V studies. In collaboration with the MECT advisors, this team reviewed site specific evaluation, measurement and verification plans prior to field data collection to ensure consistency and accuracy of the methods and analysis. This team also continues to provide technical services in the areas of data management and quality control of data collection and management to Energy Division.

The evaluations were completed in late November 2009 and reviewed by Energy Division staff and advisors prior to being posted for public comment in December 2009 and early January 2010. Public meetings were hosted via webinars for each of the evaluation reports to allow stakeholders to ask questions directly to the evaluation consultants. More than 1,700 public comments were received, reviewed, and considered for adjustments to the evaluation reports. Multiple data requests were also made by stakeholders to review the underlying data in order to inform comments on the results. The reports were finalized in February 2010 and describe in detail the methodologies, results and recommendations for the measures and programs that were included in those studies. Summaries of these report findings are included in this report [Section 2], and the full, final reports can be found on www.CALMAC.org.

1.3. The Energy Division 2006-2008 Evaluation Report

The evaluations conducted on the 2006-2008 program cycle form the foundation of the results presented in this report. This report is guided by the "Performance Basis Protocol for Verifying Performance Basis Parameters" adopted by ALJ Ruling issued in R.01-08-028 on January 11, 2006.[36] For this report, the Energy Division was required to update estimates of and report on the following parameters, as laid out by the Commission in January 2006:

- Verification of Measure Installations and Services Rendered – Program administrators report on the number of measure installations and associated program costs. The evaluations conducted of the 2006-2008 program cycle have included field and phone verification of measure installations for the majority of the programs and energy savings in the portfolios.

- Program Costs – Program administrators are expected to report on the program cost estimates. The CPUC audited program costs for 2006-2008 and determined that all costs were allowable.

- Measure or Unit Energy Savings and Peak Demand Reductions - Verify the unit energy savings estimates used by program administrators by measure or end-

[36] 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 .

use to develop program level savings estimates. The evaluations conducted of the 2006-2008 program cycle have included field based measurement of the largest programs and a majority of the key measures (High Impact Measures) generating the most energy savings in the portfolios.

- Program/Portfolio Energy Savings and Peak Demand Reductions – Energy Division includes in this report the gross and net savings for each program in the IOUs' portfolios. The methods used to apply the technology specific evaluation results to programs are outlined in the "Decision Framework" (Section 3.4) and the documentation and justification for the values that were applied are presented in Appendix C.

- Load Factors and Daily Load Shapes – Energy Division estimated the peak load impacts in all the 2006-2008 evaluations using the Gross Demand Savings Protocols[37]. Evaluators used secondary load shape data or primary interval meter data to estimate peak savings depending on the level of rigor selected by the evaluation team.

- Incremental Measure Costs – Energy Division was not able to verify the IOU-reported estimates of incremental measure costs, and accepted the utility filed incremental measure cost data.

- Avoided Costs –Energy Division reviewed avoided costs in the E3 filed calculators for consistency with the avoided cost proceeding and did not modify these values in the final evaluation work.

- Expected Useful Lives/Technical Degradation Factors – Energy Division estimated survival functions and effective useful lives for measures that were forecast to be responsible for a significant proportion of the portfolio savings. These updates were published and used for both the 2006-2008 ex-ante update as well as the 2010-2012 planning.

- Net-to-Gross Ratios (NTGR)[38] – Energy Division estimated net-to-gross ratios for technologies and programs primarily through participant in depth interviews and surveys.

Each of these updates contributed to the final evaluated impacts of the 2006-2008 energy efficiency portfolios, which are the focus of this report. The cost effectiveness of the portfolios, the emissions impacts, and long term savings impacts are all be presented in this report.

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[37] See "California Energy Efficiency Evaluation Protocols" at http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf .

[38] A ratio or percentage of net program impacts divided by gross or total impacts. Net to gross ratios are used to estimate and describe the free-ridership that may be occurring within energy efficiency programs. Free-ridership represents the portion of energy efficiency program participants who would have installed an energy efficiency measure even in the absence of an IOU program. See EE Policy Manual, Version 4.0, at http://www.cpuc.ca.gov/NR/rdonlyres/F17E8579-3409-4089-8DE4-799832CF682E/0/PolicyRulesV4Final.doc .

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

Table 13. 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
Content	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
Purpose	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
Timeline	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

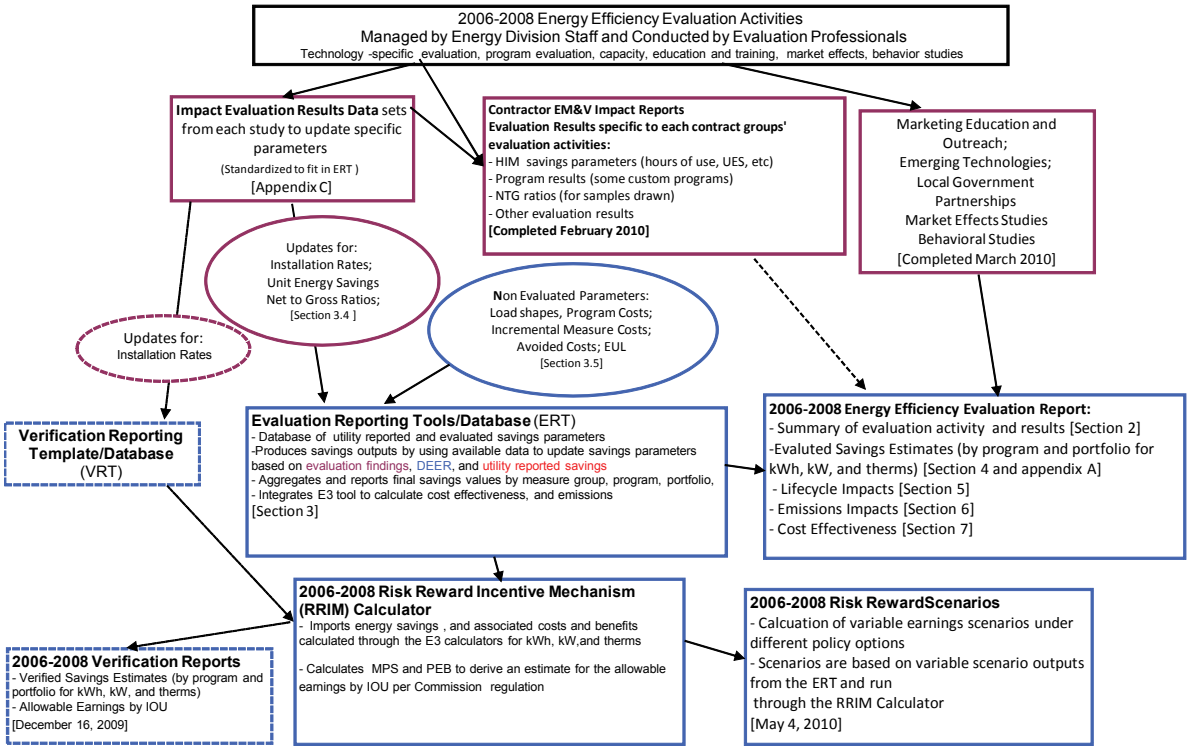
The path of evaluation research and outputs that have culminated in the production of this report are presented in Figure 8.

As noted in the prior section, the evaluation contractors were hired to evaluate groups of similar programs and several of these studies focused evaluation resources on a number of technologies that had a significant influence on portfolio level savings or HIMs.

The data sets from these studies were used as the foundation to make updates to utility reported energy savings parameters. For this report, the Energy Division is required to update estimates of and report on specific parameters, as laid out by the Commission in January 2006.[39] Energy Division required the evaluation contractors to submit the results of their studies in a standardized format consistent with the official cost-effectiveness tools that would relate to the utility reported savings at the most detailed technology level. Energy Division also developed a guidance document for the evaluation contractors to ensure that the datasets and the updates that they provided were consistent and in accordance with policy requirements. The guidance provided to the contractors was called the 'Decision Framework' [Section 3.4], and allowed for updates to installation rates (how many technologies were installed an 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). There were also several parameters that were not updated with evaluation results but were part of the data set, these primarily included cost data. 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.

[39] See "Gottstein Ruling Adopting Protocols for Process and Review of Post-2005 EM&V Activities" in Rulemaking 01-08-028 at http://docs.cpuc.ca.gov/PUBLISHED/RULINGS/52676.htm .

Figure 21. Relation of Evaluation Activities, Results and Reporting



Concurrently, the Energy Division Staff developed a standardized database of the utility reported savings to allow for the systematic update of each parameter in that database. The first and second Verification Reports released by Energy Division utilized a tool called the "Verification Reporting Template" (VRT), which is a database that processes the updated utility and produces utility-specific savings and benefits results. In anticipation of this final Energy Division report, a similar database and set of tools were designed (the Evaluation Reporting Tools or ERT) to address the added complexity of updating multiple parameters and many more programs for purposes of this final report (the VRT could only be used to update single parameters for a subset of the programs). This process and the ERT tool is described in detail in Section 3, and the required parameter updates are described in the following sub section 3.4.

All of the evaluated data points and the utility reported data points were imported into a centralized database called the ERT application to produce aggregate impacts by utility, program or technology. These tools allowed for the aggregation of evaluation results from the technology specific evaluations (HIM designs) which cut across programs. The resultant data set has the multiple benefits of providing estimates of savings, benefits, and costs for each IOU or the IOUs combined, for specific programs, or for technologies. It allows for parameter updates to be turned "on" and "off" in order to gauge the relative influence of any given evaluation update on the reported savings. This tool is discussed in great detail in Section 3, and all of the energy savings, emissions, lifecycle savings, emissions and cost effectiveness information presented in this report are based on the outputs from these tools and the evaluation results.

The ERT also allows Energy Division to calculate 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 on May 4, 2010, that will specifically address the Risk Reward Incentive Mechanism.

2. FINDINGS AND RECOMMENDATIONS FROM 2006-2008 IMPACT EVALUATION REPORTS

The 2006-2008 Resource and Non-Resource Impact Evaluation Reports were finalized in February 2010. 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. The evaluation reports were subject to an extensive public review process and provide key information regarding measure performance and the effectiveness of a wide variety of market approaches for achieving energy efficiency savings directly and indirectly. The findings and recommendations from these studies are currently the focus of joint meetings with the program implementers and Energy Division staff to incorporate the findings into program adjustments and improvements in the 2010-2012 program cycle.

The study results also form the foundation for updating the utility reported savings parameters and calculating the evaluated savings that are included in this report. As such they were conducted in strict compliance with the policy rules described in Section 1 of this report. The parameter updates are derived from both measure specific studies (HIM) and program evaluation findings. The detailed description of how these results were applied in the final estimate of savings is described in Appendix C.

A caveat in reviewing these findings: many of the evaluation results are framed in terms of realization rates, which are the evaluated estimates of savings divided by the utility reported estimates of savings. In isolation these realization rates do not convey qualitative information about the relative value of energy efficiency savings as compared to other resource options. Neither a high or a low realization rate provides information on the absolute size of value of the energy efficiency impacts, it is simply a comparison of the savings estimates available before the program started and after field evaluation was conducted.

The Final Evaluation Reports present evaluation results for the sixteen contract groups or evaluation teams that comprise the resource and non-resource evaluation projects. The evaluation projects are split between eleven contract groups that evaluated resource programs and five contract groups that evaluated non-resource programs.[40]

[40] Resource programs typically 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 on the benefits of energy efficiency as well as pushing for energy efficiency technologies and practices through advocacy programs like the Codes and Standards programs.

Table 14. Evaluation Teams for 2006-2008

Evaluation Contract Group	Energy Division Project Manager	Lead Evaluation Firm	Evaluation Budget
Resource			
New Construction/ Codes & Standards	Ayat Osman	KEMA	$7.0 million
HIM: Whole Building			
Residential Retrofit/Upstream Lighting	Mikhail Haramati	Cadmus	$18.7 million
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			
Commercial Retro-commissioning	Jeorge Tagnipes	SBW	$3.2 million
HIM: Retro-commissioning			
Local Government Partnerships	Jeorge Tagnipes	Summit Blue	$7.9 million
Major Commercial	Jeorge Tagnipes	SBW	$4.9 million
HIM: On-site Audit, custom lighting, custom HVAC, custom other			
Small Commercial	Jeorge Tagnipes	Itron	$8.9 million
HIM: high-bay fluorescent			
Specialized Commercial	Jeorge Tagnipes	KEMA	$4.6 million
HIM: Refrigerant Charge Airflow, AC replacement, Duct Sealing			
Commercial Facilities	Kay Hardy	ADM	$3.2 million
HIM: Refrigeration Door Gasket and Strip Curtains			
PG&E Agricultural & Food Processing	Kay Hardy	KEMA	$1.7 million
HIM: Greenhouse Heat Curtains and IR Film			
PG&E Fabrication, Process & Manuf.	Kay Hardy	Itron	$4.3 million
HIM: Pump-off controllers			
SCE Industrial & Agriculture	Kay Hardy	Itron	$4.4 million
HIM: Pump tests, Steam Traps, Pipe Insulation			
Non-Resource			
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			

The following sections provide high level summaries of the findings from these studies and table includes a list with links to the final full evaluation reports posted on the CALMAC website.

Table 15. Links to Final Impact Evaluation Reports

Non-Residential New Construction
http://www.calmac.org/publications/NRNC_Final_Report_02082010.pdf
http://calmac.org/publications/NRNC_Appendices_Part1_02082010.pdf
http://www.calmac.org/publications/NRNC_Appendices_Part2_02082010.pdf
Residential New Construction
http://www.calmac.org/publications/RNC_Final_Evaluation_Report.pdf
http://www.calmac.org/publications/RNC_Appendices_Vol_I_02-19-10.pdf
Residential Retrofit/Upstream Lighting
http://www.calmac.org/publications/FinalResidentialRetroEvaluationReport_11.pdf
http://www.calmac.org/publications/FinalResidentialRetroEvaluationAppendices.pdf

http://calmac.org/publications/FinalUpstreamLightingEvaluationReport_Vol1_CALMAC_3.pdf
http://calmac.org/publications/FinalUpstreamLightingEvaluationReport_Vol2_CALMAC.pdf
Commercial Retro-commissioning
http://www.calmac.org/publications/RCx_2006-08_EM&V_Report_FINAL.pdf
http://www.calmac.org/publications/RCx_2006-08_EM&V_Report_FINAL_-_Vol_1.zip
http://www.calmac.org/publications/RCx_2006-08_EM&V_Report_FINAL_-_Vol_2.zip
http://www.calmac.org/publications/RCx_2006-08_EM&V_Report_FINAL_-_Vol_3.zip
Local Government Partnerships
http://www.calmac.org/publications/06-08_Government_Partnerships_Programs_Direct_Impact_Evaluation_Report.pdf
http://www.calmac.org/publications/LGP_Evaluation_Report_Appendix_Volume_1_-_Appendices_A_-_D.pdf
http://www.calmac.org/publications/LGP_Evaluation_Report_Appendix_Volume_2_-_Appendices_E_-_I.pdf
Major Commercial
http://www.calmac.org/publications/Major_Commercial_2006-08_EM&V_Report_FINAL_-_VOL_1.pdf
http://www.calmac.org/publications/Major_Commercial_2006-08_EM&V_Report_FINAL_-_VOL_2a.zip
http://www.calmac.org/publications/Major_Commercial_2006-08_EM&V_Report_FINAL_-_VOL_2b.zip
Small Commercial
http://www.calmac.org/publications/Report_NoApps.pdf
http://www.calmac.org/publications/Report_AppsA-D.pdf
http://www.calmac.org/publications/Report_AppsE-M.pdf
Specialized Commercial
http://www.calmac.org/publications/Vol_1_HVAC_Spec_Comm_Report_02-10-10.pdf
http://www.calmac.org/publications/Vol_2_Specialized_Commercial_Report_APPENDICES_02-10-10.pdf
Commercial Facilities
http://www.calmac.org/publications/ComFac_Evaluation_V1_Final_Report_02-18-2010.pdf
PGE Agricultural & Food Processing
http://www.calmac.org/publications/PG&E_Ag-Food_Eval_Report_V1_021010.pdf
http://www.calmac.org/publications/PG&E_Ag-Food_Eval_Appendices_V2_021010.pdf
http://www.calmac.org/publications/PG&E_Ag-Food_Eval_Appendices_V4_Public_Comments-Responses_021010.pdf
PGE Fabrication, Process & Manuf.
http://calmac.org/publications/PG&E_Fab_06-08_Eval_Final_Report.pdf
http://calmac.org/publications/PG&E_Fab_06-08_Eval_Final_Report_Appendices.pdf
SCE Industrial & Agriculture
http://calmac.org/publications/SCIA_06-08_Eval_Final_Report.pdf
http://www.calmac.org/publications/SCIA_06-08_Final_Report_Appendices-No-Site_Reports.pdf
Codes and Standards
http://www.calmac.org/publications/Codes_Standards_Vol_III_FinalEvaluationReportUpdated_04122010.pdf
http://www.calmac.org/publications/CS_AppendicesUpdated_04-12-2010.pdf
Emerging Technologies
http://www.calmac.org/publications/Final_Comprehensive_ETP_Final_Report_02-04-10_R7_3.pdf
http://www.calmac.org/publications/Final_Comprehensive_ETP_Final_Report_Appendices_02-04-10_R3.pdf
Local Government Partnerships
http://www.calmac.org/publications/Local_Government_Partnership_Non-Resource_Evaluation_Report-FINAL_1262010v2_km.pdf
http://www.calmac.org/publications/Local_Government_Partnership_Non-Resource_Evaluation_Appendices-FINAL_1262010_km.pdf
Statewide Marketing/Outreach
http://www.calmac.org/publications/CPUC_SWMO_Integrated_Indirect_Impact_Report_VolI_022410.pdf
http://www.calmac.org/publications/CPUC_SWMO_Integrated_Indirect_Impact_Report_VolII_121809.pdf

Statewide EE Education/Training
http://calmac.org/publications/06-08_Statewide_Education_and_Training_Impact_Eval_Vol_I_FINAL.pdf
http://calmac.org/publications/06-08_Statewide_Education_and_Training_Impact_Eval_Vol_II__FINAL.pdf
http://calmac.org/publications/06-08_Statewide_Edcuation_and_Training_Impact_Eval_Vol_III_FINAL.pdf
http://calmac.org/publications/06-08_Statewide_Education_and_Traning_Impact_Eval_Vol_IV_FINAL.pdf
Education and Information
http://www.calmac.org/publications/ODC_CPUC_0608_Edu_and_Info_Impact_Eva_VoI_Final.pdf
http://www.calmac.org/publications/ODC_CPUC_0608_Edu_and_Info_Impact_Eva_VoII_Final.pdf
http://www.calmac.org/publications/ODC_CPUC_0608_Edu_and_Info_Impact_Eva_VoIII_Final.pdf

2.1. Residential Programs

2.1.1. Residential Retrofit Evaluation

The residential retrofit programs utilized a number of program implementation strategies to encourage customers to make energy efficient improvements in their homes. These strategies included upstream and downstream customer rebates, home energy audits, contractor incentives, appliance recycling rebates, and direct installation of efficient devices in single family and multi-family residences. Upstream lighting and Heating Ventilation and Air-conditioning (HVAC) measures were offered through the residential retrofit group of programs. Residential new construction programs were offered primarily to contractors and builders.

The Residential Retrofit evaluation covered a very significant portion of the total portfolio in 2006-2008.

The evaluation focused on the 13 Residential Retrofit high impact measures (HIMs), which were selected by identifying all measures that represented more than 1% of the energy savings claimed by any IOU. The research conducted for these HIMs included 24,475 evaluation data collection points, including telephone surveys, onsite verification, field metering, focus groups, retailer interviews, and equipment lab testing.

Additionally:

- 79% of claimed savings (kWh) from the Residential Retrofit measures are attributable to Upstream Lighting.
- Appliance recycling accounts for 13% of claimed savings (kWh) from the Residential Retrofit measures.
- Remaining claimed savings are Downstream Lighting (5%), HVAC (2%), Room AC (1%) and Pool Pumps (< 1%).

Findings

The findings varied greatly among the residential HIMs, but there were several overarching themes across many of the residential retrofit HIMs:

- ***Data inconsistencies, especially between E3 calculators and tracking data:*** There were numerous examples of missing and/or incorrect measures and erroneous assignments. *This can be corrected by providing a consistent unique ID associated with each transaction/record within the IOU tracking database that does not change by reporting year/quarter, and by providing a consistent unique ID associated with each E3 line item to ensure there are not duplicative records in the E3.*
- ***Free-ridership was significantly higher than utility claims:*** For example, the National ENERGY STAR retailer partner data has demonstrated consistently high market share for ENERGY STAR dishwashers, even after standard changes in 2007, providing some evidence of high baseline sales of efficient equipment (i.e., high free-rider/free-ridership). *The programs should monitor any market data for similar*

evidence, and consider adjusting program offerings to focus on higher-efficiency products (e.g., more efficient CEE[41] tier levels).

- ***The Unit Energy Savings (UES) claimed were not always reflective of updated DEER values and there was not always clear documentation on how the values were derived:*** There were a number of examples, including furnaces and dishwashers, where DEER values were incorrectly applied (e.g., one utility apparently mistakenly claimed the dishwasher annual kWh savings as the annual therm savings). In addition, in a number of cases (e.g., clothes washers, showerheads/aerators, insulation, and room ACs), the full set of work papers that were used to determine the claimed savings values were not available. *The source of the claimed savings values should be fully transparent to any reviewer.*

The evaluation resulted in a number of important measure- and program-specific findings and recommendations, including:

- ***Furnaces***: The findings relating to the temperature set points indicate that additional study is needed to determine the actual gas consumption of furnaces at the different efficiency levels across climate zones and to measure the sensitivity of these set-points to actual weather conditions, fuel prices and economic conditions. At a minimum, it would appear that the assumptions in DEER should be updated to reflect the actual settings that occupants are using.

- ***Clothes Washers***: As both electric and gas savings were documented during our evaluation activities, dual-fuel utilities like SDGE may wish to consider claiming savings on both fuels for efficient clothes washers. Further investigation regarding the amount of dryer usage and alternative drying methods may also be warranted as part of future evaluation efforts.

- ***Showerheads and Aerators***: Future evaluations should consider modeling the change in actual hot water usage based on the installed measure definition. The change in hot water use (measured in gallons per day) is a critical parameter and modeling impacts would benefit from current pre- and post-measurement data. Additionally, IOUs should coordinate closely with water utilities to avoid duplication of efforts.

- ***Insulation***: Utilities should conduct more frequent and rigorous site inspections to check that installations are meeting program eligibility requirements. This evaluation found that a substantial number of insulation participants did not meet the program eligibility requirements, typically because pre-existing attic insulation exceeded the program limit of R-11 or wall insulation was already present or installed between two similarly conditioned/unconditioned spaces.

- ***Refrigerator Recycling***: The evaluation recommends that future evaluations utilize *in situ* metering (as opposed to the United States Department of Energy lab testing,

[41] Information on the Consortium for Energy Efficiency (CEE) can be found at http://www.cee1.org .

or a combination of approaches) to evaluate the savings generated by refrigerator recycling. *In situ* better accounts for usage and household characteristics in the participating population compared to lab testing, plus standalone *in situ* metering would reduce evaluation costs while still achieving robust results. The evaluation further recommends that greater emphasis be placed on quality control related to data collection, including the accurate collection of all relevant appliance characteristics such as configuration, age, and size. These are critically important to the estimation of gross savings.

- ***Pool Pumps and Motors***: Utilities should consider conducting enhanced verification to ensure that program participants are eligible for incentives. For example, the evaluation found that approximately 20% of SDGE's Residential Incentive program participants had installed pumps that were not eligible for the program. In addition, 30% of the Residential Incentive program's Pool Pump Reset Agreement participants reported on their applications that they were not running during peak hours prior to participation (and thus ineligible), yet these customers were still sent incentives and included as program participants.

- ***Downstream Lighting Program***: The Downstream Lighting Programs should provide more accurate and verifiable data in the IOU tracking database so third-party evaluators may easily verify measures. The tracking data was of limited value, in many cases not identifying the location of the installed measure. The programs should also improve the quality of the program fixtures to mitigate early failures and make sure that property managers have spare bulbs and access to low-cost replacement bulbs.

2.1.2. Upstream Lighting

There were three types of HIMs addressed in the upstream lighting portion of the residential retrofit evaluation: screw-in compact fluorescent lamps (CFLs), energy efficient lighting fixtures, and light emitting diode (LED) measures.

Overall, the IOUs realized about 25% of their ex-ante claims for net energy and 20% of their peak demand reduction claim. Key drivers of these low realization rates include:

- ***The existence of unverified bulbs:*** The quantity of all measures rebated was adjusted downward by about 13% to account for measures not verified, not sold through December 31, 2008, and not sold to IOU customers. (Note that bulbs sold at a later date may still result in future energy savings.)

- ***The split between residential and non-residential customers***: In general, the evaluation determined that approximately 95% of the rebated measures were installed in residential locations as compared to the 90% assumed by PGE and SCE and 100% assumed by SDGE.

- ***Lower than expected installation rates:*** Screw-in CFL installation rates were found to be about 15% lower than ex-ante estimates for residential measures, and about 7% lower for nonresidential measures.

- ***Lower than expected Unit Energy Savings:*** Per unit gross savings estimates were reduced by about half due to ex-post adjustments to the estimates for annual operating hours, peak coincidence factors and delta watts[42].

- ***A very high number of free-riders:*** The recommended NTGR estimates were reduced by about half for PGE, and a little more than one third for SDGE. SCE's ex-ante NTGR value was lower than the other two IOUs to begin with and the ex-post value was the highest of the three, resulting in only about a 15% reduction.

The following high-level recommendations were made for the improvement of future programs:

- IOUs should use the results of this evaluation to validate/modify ex-ante energy savings and peak demand impacts for 2010-2012, especially for key parameters estimated through this evaluation including: leakage rates, residential v. nonresidential sales, installation rates, HOU, peak CF, and NTGR values.

- IOUs should be required to improve their processes for program documentation, tracking and reporting to increase verification rates and better manage program operations. Specifically, IOUs should improve the accuracy, consistency, completeness and quality of program documentation submitted to substantiate claims. At a minimum, sales data and/or sell-through reports should be required on at least a quarterly basis if not monthly. These reports plus additional documentation should be provided for every product rebated so that independent verification can be completed on a regular basis.

- IOUs should minimize sales to non-IOU customers, monitor the market for evidence of leakage both prior to and after the initial sale, and report quarterly on the results of these efforts.

- IOUs should continue to rebate basic twister/spiral-style CFLs but only within selected retail stores (i.e., discount stores, discount grocery chains, small/independent grocery stores, and small/independent stores of any type located in rural areas). IOUs should eliminate rebates for basic twister/spiral-style CFLs in "big box" stores within the large home improvement, mass merchandise, and membership club channels. Subsidization of any type of CFL should be considered a short-term strategy in light of upcoming changes to federal lighting efficacy regulations.

- The Downstream Lighting Programs should provide more accurate and verifiable data in the IOU tracking database so the measures can be more easily verified by third party evaluators. The tracking data was of limited value, in many cases not identifying the location of the installed measure. The programs should also improve

[42] "delta watts" refers to the wattage difference between the bulb that was in place and its replacement.

the quality of the program fixtures to mitigate early failures and make sure that property managers have spare bulbs and access to low-cost replacement bulbs.

2.1.3. HVAC

The residential HVAC evaluation looked at a grouping of programs and measures consisting of three heating, ventilation and air-conditioning high impact measures (HVAC HIMs). These included refrigerant charge and airflow (RCA), AC replacement, and duct sealing. The final HVAC HIM evaluated savings yielded lower gross savings than the ex-ante estimates for most program-HIM combinations.

Findings

NTG values

- Residential RCA within PGE's Mass Market program had a significant amount of free-ridership; over half of the respondents admitted to having installed the measure before they learned of the program.

- Residential AC Replacement within SCE's Comprehensive HVAC program and SDGE's Upstream HVAC/Motors program used survey questions to determine whether the contractor influenced the end-user's decision to purchase a high-efficiency air conditioner. The NTGR was affected by significant marketing around high efficiency air conditioners and the amount of "green" messaging from multiple sources during the last five years.

- Residential Duct Seal within PGE's Mass Market program: over half of the respondents indicated that they had multiple free-ridership measurements, and over half of the respondents admitted to having installed the measure before they learned of the program.

Realization Rates

- For Residential RCA, the evaluation team used instrumentation expected to produce more precise measurements and expected the rates to be lowered due to the use of more precise tools.

- For Residential Duct Sealing, measured leakage data for all of the sample groups showed diversified results. While it is possible that the service contractors at the sites made some efforts to seal the duct work, it is believed that some of these units never had any work performed.

Recommendations

- *RCA* - establish an independent service tool list and protocol for residential RCA verification testing and standard tables, data definitions, and data quality procedures to validate program-collected and evaluator-collected data. Additionally, the programs need strong links of rebates and savings data to

program units and contractor measurement data; this includes statewide unit identification standards and stickers.

- *AC Replacement* - correct field installation issues to improve overall performance. IOUs should also use the most recent Commission definition of peak demand for consistency.

- *Duct Sealing* - explore the use of advanced testing methodologies and create an incentive program for contractors to insure quality duct sealing jobs.

2.1.4. Residential New Construction Evaluation

Residential New Construction – Single Family

The four residential new construction programs—the Advanced Home Program for SCG and SDGE, the California New Homes Program for SCE, and the Residential New Construction Program for PGE—all offered energy efficiency incentives for residential new construction, including both whole house and prescriptive measures. PGE's program focuses primarily on single-family buildings, with multifamily buildings under a separate program. The remaining programs include both single-family and multifamily components under the same program.

The study collected detailed on-site data and end-use metering at 131 non-participant single family RNC sites across the state. The results of the data collection were used to characterize the energy use of typical new homes and to compare the metered energy use of homes in the study to the energy use of the same homes as modeled using the Title 24 compliance tool (MICROPAS).

Findings

- The RNC program's largest source of net energy savings was cooling end-uses in single family homes.
- In the Inland region, new single family homes (NP) on average did not meet T24 cooling requirements; a proportion of the net electric savings were the result of this low performance of the baseline group.
- Significant naturally-occurring gas savings were present for heating and water heating, translating to high gas free-ridership.
- Metered data indicated that the compliance software (MICROPAS), which is required by the California Energy Commission, overestimates the amount of heating energy consumed at a site and under-estimates the amount of cooling energy consumed. Therefore, ex-ante electric and demand savings estimates were too low compared to ex-post results (hence the high realization rates); and ex-ante therm savings estimates were too high compared to ex-post results (hence the low realization rates).
- The evaluated results for all IOUs exceeded electric and gas whole house SF RNC claims with the exception of SDGE, which did not claim whole building savings.

Recommendations

- IOUs should evaluate alternative modeling tools that more accurately simulate energy usage for ex-ante estimates (consider DOE2 and EnergyPlus).

- The orientation of a home significantly affects its space-cooling and heating energy requirements, and the costs of ignoring orientation can be quantified. Building code compliance registries should record home orientations in order to dramatically improve the accuracy of program performance estimates.
- IOUs should track participation information in a common, well-constructed, accurate and complete database.
- IOUs should collect compliance forms in addition to the results of the compliance documentation contained in the CHEERS and CalCerts registries.
- Metering data studies should further explore residential usage patterns for builder-affected end-uses like HVAC, cooling and water heating (to build complete annual hourly load curves for each end use). Further, mining of collected data could estimate the impact on compliance and overall residential consumption in the state, with particular attention to solar gains that affect heating and cooling energy usage.
- The RNC market effects study recommended that the RNC program take better advantage of the established Energy Star for branding.
- Given that the baseline homes tended to under-comply with code on cooling, and that Inland climate zones represent high energy intensity opportunities, the IOUs should consider targeting these areas for high program penetration.

California Multi-Family Homes Evaluation (PGE)

PGE's California Multifamily New Home Program facilitates energy-efficient design and construction in multifamily housing through design assistance, cash incentives and ENERGY STAR® marketing benefits to both low-rise and high-rise multifamily projects. As of the fourth quarter of 2008, the program only reported 10% of its original projected savings prior to evaluation.

Findings

- 53 total projects and 3,446 housing units were completed.
- Interviews were performed with 33 people representing 22 unique projects.
- Only approx 10% of projected program savings were achieved.
- Overall NTG ratio was decreased from 0.8 (ex-ante) to 0.58 (ex-post).
- 14 of 17 plans submitted to the implementer exceeded T24 (by average 20%).
- Eight of the 17 plans nonetheless reported changes to plans as a result of implementer input, although "few projects were strongly influenced by the project to achieve higher efficiency" and only 3 projects stated that IOU program was critical to decision to build to 15% above T24 code.
- Main reason- to access a CA low-income tax incentive (CA Tax Credit Allocation Comment).
- Two respondents said exceeding code was standard practice for firm, and one was seeking LEED certification.

Recommendations

- High free ridership for appliances indicates that appliances track for program qualification should probably be dropped from the program or, at a minimum, their minimum efficiency criteria increased.

- Free ridership for the performance track is lower among affordable projects than among market-rate projects, which suggests that the program may be able to reduce/eliminate incentives for market-rate projects.
- Alternatively, the program could increase the target level of efficiency above code for performance projects; the current level is 15% above code.

Designed for Comfort (SCE and SCG)

SCE and SCG Designed for Comfort (DfC) programs provide incentives for the replacement of inefficient heating, cooling, and water heating equipment, insulation, and windows with models of higher efficiency. The goal of the DfC program evaluation was to determine whether program measures were installed (yes/no) and whether they were installed properly. The evaluation consisted of on-site evaluations at two multifamily affordable housing complexes.

Recommendations

- HERS verification and QC inspections should emphasize caulking on exterior windows above the ground floor and the depth of attic insulation.
- Require or incentivize hot water pipe insulation.
- Educate facility staff fully about savings from lowering water heating temperature settings.
- Tenant training should emphasize thermostat settings and grill obstructions.

2.2. Commercial Programs

The findings in this section are summarized from six separate evaluations: Small Commercial, Specialized Commercial, Major Commercial, Commercial Retro-Commissioning, Commercial Facilities, Government Partnership, and Non-Residential New Construction resource evaluations.

2.2.1. Small Commercial Evaluation

The Small Commercial grouping generally involved direct install and prescriptive rebate programs that targeted small- to medium-sized non-residential customers in the PGE, SCE, and SDGE service territories. Technologies offered through these programs included audits, food service, lighting technologies, controls, and HVAC systems. Both IOU third party and local governments were involved in program implementation.

The evaluation focused on five high impact nonresidential lighting measures in the PGE, SCE, and SDGE service territories: interior screw lighting, linear fluorescents, high bay fluorescents, upstream interior screw lighting, and occupancy sensors. Field work conducted for the evaluation included: 1,250 nonresidential site visits to determine the percentage of rebated measures that were actually installed and operable; time-of-use data collected on 1,085 nonresidential sites; and over 3,000 participant surveys performed to estimate free-ridership.

Findings

- Occupancy Sensors and non-lighting measures – low net realization rates are a result of relatively high ex-ante NTGRs and ex-post NTGRs estimated using a self-report approach that resulted in significantly lower NTGRs.
- Interior Screw Lighting – The self-report NTGR was significantly lower than the ex-ante NTGR (68% of ex-ante) NTGR . Thirty percent of the measures were not verified (not found to be in place and operating). Finally, the ex-post unit energy savings (UES) were found to be only 30% of the ex-ante UES due to lower operating hours and delta wattages (the wattage difference between a bulb that is replaced and the replacement bulb). The lower operating hours were primarily driven by high participation in hotel guest rooms, and to a lesser extent in bathrooms and other market segments.
- Linear Fluorescents – The self-report NTGR was significantly lower than the ex-ante NTGR (86% of ex-ante). Furthermore, seven percent of the measures were not verified. Lastly, the ex-post unit energy savings (UES) were 63% of the ex-ante UES due to lower operating hours and wattage differences between bulbs that were replaced and replacement bulbs.
- High-bay Lighting – The self-report NTGR was significantly lower than the ex-ante NTGR (80% of ex-ante). Furthermore, 6% of the measures were not verified. Lastly, the ex-post unit energy savings (UES) were found to be only 68% of the ex-ante UES due to lower operating hours and wattage differences between bulbs that were replaced and replacement bulbs.

Recommendations

- For CFLs, the lodging market segment should be avoided in future programs, as it has the highest rate of free ridership and the lowest operating hours among all CFL market segments.
- Future evaluation efforts would benefit from improved program tracking data. Measure names should be consistent across programs and utilities, information on the replaced equipment should be documented, more accurate installation dates should be recorded, and all meters impacted by a retrofit should be documented (instead of just one meter).
- On-site verification and telephone surveys (for establishing net-to-gross ratios) should be conducted in waves soon after customer participation. This would improve customer recall, provide better feedback and improve the accuracy of estimates of burn-out and storage rates.
- Future evaluations should consider a dual baseline for linear and high bay fluorescent measures, where existing equipment is treated as a baseline only for the remaining useful life of the replaced equipment. For years beyond the remaining useful life, through the measure's effective useful life, the baseline would be set equal to minimum code requirements.

2.2.2. Specialized Commercial Evaluation

Originally, programs included in the Specialized Commercial grouping were so diverse and unique that they required specialized evaluation skills, as the technologies offered were newer or emerging technologies that had not been thoroughly evaluated in the past. Because many of these programs did not produce significant savings, the evaluation focused on programs that typically involved midstream incentives to contractors to deliver HVAC improvements to both commercial and residential customers. The technologies offered through these programs covered all four IOU service territories.

The evaluation focused on high impact heating, ventilation, and air-conditioning (HVAC) measures as well as non-high impact measures. The high impact HVAC measures included refrigerant charge and airflow (RCA), AC replacement, and duct sealing. The non-HIM programs included: Management Affiliates Partnership Program, Energy-Efficiency Program for Entertainment Centers, Upstream HVAC/PTAC, and Upstream HVAC/Motors Program. This evaluation conducted 5,700 phone surveys, verified 1,450 sites, and metered 1,000 sites.

Findings

- Residential RCA with PGE2000 (Mass Market) had a significant amount of free-ridership, with over half of respondents admitting to having installed the measure before they learned of the program.
- C&I RCA within PGE2080 (Non-Residential Mass Market) and PGE2068 (AirCare Plus) had about half of respondents with no free-ridership data and the other half with one free-ridership measurement. The respondents who were aware of the program

may not have fully understood their contractor's participation and the contractors who were identified were less responsive than participants.

- Residential AC Replacement within SCE2507 (Comprehensive HVAC) and SDGE3029 (Upstream HVAC/Motors) used survey questions to determine whether the contractor influenced the end-users' decision to purchase a high-efficiency air conditioner. The NTGR was a result of the marketing around high-efficiency air conditioners and the amount of "green" messaging from multiple sources during the last five years.
- Residential Duct Sealing within PGE2000 (Mass Market) had over half the respondents indicate that they had multiple free-ridership measurements, and over half of the respondents admitted to having installed the measure before they learned of the program.
- For Residential RCA, the evaluation team used instrumentation expected to produce more precise measurements and expected the rates to be lowered due to the use of more precise tools.
- For Residential Duct Sealing, measured leakage data for all of the sample groups showed diversified results. While it is possible that the service contractors at the sites made some efforts to seal the duct work, it is believed that some of these units never had any work performed.

Recommendations

- *RCA* - programs should establish an independent service tool list and protocol for residential and commercial and industrial (C&I) RCA verification testing and standard tables, data definitions, and data quality procedures to validate program-collected and evaluator-collected data, leading to a more transparent and standardized process.
- The programs should eliminate discrepancies between contractor measurement data and program tracking data that contains savings and costs. This will improve tracking of whether the work performed matches the associated savings and costs and eliminate sampling issues related to inconsistent data in the tracking and implementation databases. This may be achieved through the use of statewide unit identification standards and stickers.
- *AC Replacement* – Field installation issues should be corrected to improve overall performance. While actual savings are affected by user behavior, AC efficiency is defined by independent lab measurement and primarily affected by installation issues such as incorrect charge, bad sizing, or coil damage. IOUs should also use the most recent Commission definition of peak demand for consistency.
- *Duct Sealing* - advanced testing methodologies should be explored, as well as the creation of a tiered incentive mechanism for contractors to insure quality duct sealing jobs. Current testing does not specify leak locations but gives an estimate of all leakage in the duct system, and the most important leaks are often difficult to seal and require more time. An incentive mechanism may encourage contractors address these more hard-to-reach leaks.

- *CO Sensors* –documentation of estimated fan reduction and exhaust flow received from contractors should be improved; additional sites in appropriate climate zones and among various building types should be monitored to improve validity of the results.

- *Energy Efficiency Program for Entertainment Centers (movie theaters)* - disallow the replacement of packaged terminal heat pump units with packaged terminal AC units.

2.2.3. Commercial Retro-Commissioning Evaluation

Retro-commissioning involves the systematic optimization of a building's systems and operation through the use of an independent retro-commissioning agent who conducts a detailed study of the entire facility. PGE, SCE, SCG, and SDGE all offered programs that implemented retro-commissioning projects. The programs primarily involved government partnerships (such as LA County, University of California, and the Community Colleges partnership) and also included programs targeting the hospital, large retail, large office buildings, and data center sectors.

The evaluation focused on 225 retro-commissioning projects from more than two dozen programs offered by the four IOUs. The field work included: 120 customer interviews, 300 measures evaluated, 82 sites visited, and over 13,798 data logger days worth of data collected.

Findings

- Across the 24 projects in the PGE gross sample, there were 41 significant reasons for differences, over 75% of which worked to reduce savings. Critically, nearly two-thirds of these savings-reducing reasons were instances in which the RCx measure was wholly or partially inoperable. Another common reason was discrepancies between program calculation assumptions and actual conditions.

- The number of RCx projects varied tremendously between IOUs. PGE claimed 135 projects, nearly two-thirds of the RCx population of 225 projects. In contrast, SDGE claimed four projects, all of which occurred at the same university campus. On an energy basis, the PGE RCx projects accounted for about half of the claimed and evaluated savings.

- Programs that cover all or part of the cost of the RCx study reduce the risk associated with an RCx project significantly and lead many organizations to proceed with the project. Incentives that cover the cost of the study received the highest mean rating for all program influences cited by respondents—even higher than incentives for implementing recommended measures.

Recommendations

- Participants should be provided with adequate follow-up RCx services. Additionally, RCx service providers should have a reduced burden for quantifying energy savings, and program staff should have primary responsibility for collecting baseline data.

- Baseline data collection should be improved. Additional evaluation-related recommendations include: specifying post-only sample designs, balancing the need for accurate first-year savings against the need to track savings over time, maximizing time allotted for onsite data collection, and minimizing use of whole building analysis.
- The measure classification scheme should continue to be refined. Additionally, the relative effectiveness of different programmatic approaches should be studied, including a comparison of retro- and monitoring-based commissioning.

2.2.4. Major Commercial Evaluation

The Major Commercial grouping included non-residential audits and utility incentive programs for large customers. The non-residential audit programs for SCE and SCG deliver energy efficiency information, awareness, and efficiency project recommendations to commercial and industrial customers. The utility incentive programs for large customers varied by IOU; they generally provide incentives for large commercial customers to undertake energy efficient retrofit projects which are often complex and customized to a customer site. PGE did not have any programs in the Major Commercial grouping.

The evaluation included four high impact measures in the SCE, SDGE and SCG service areas: custom lighting, custom HVAC, "custom other" and audit. Unlike the small and specialized commercial evaluations, which involved prescriptive measures, the sites included in this evaluation were considered custom projects. The field work included 394 phone surveys, 67 site visits for direct measures and 16 site visits for the audit sites.

Findings

- The net-to-gross ratios (NTGR) for SDGE3010 (Energy Savings Bid) are significantly higher for each metric because the program has a substantially different delivery strategy than the other 3 programs. The program's third-party delivery and aggregation of smaller projects allows for participation from customers who are unable or unwilling to participate in the statewide Express Efficiency or SPC programs. The level of proactive program involvement is also greater than that in the other three programs, resulting in higher program influence.
- NTGR for the remaining three programs range from 0.54 to 0.59, depending on the program and energy metric. Sampled projects for two of these programs (SCE2517/Business Incentives and Services and SDGE3025/SPC), reflect the Standard Performance Contract (SPC) program delivery model. The third program, SCG's Business Energy Efficiency Program (SCG3513) also uses a delivery approach that is substantially similar to the SPC model. These NTGR values are very similar to the NTGR estimate of 0.54 for the statewide SPC program in the PY2004-2005 evaluation. Additionally, they are very similar to the NTGR estimates made in prior SPC evaluations conducted for each program year since the program's inception in 1998. These values are also in line with those found for the Northern California

Industrial contract report, which reflects programs that are largely based on the SPC approach.

Recommendations

- Improved inspection and documentation of baseline conditions will improve understanding of the energy performance of the baseline equipment.
- Savings from normal replacement measures that are required by Title 20/24 or are standard practice for the facility should not be claimed. Program application files should provide documentation that discusses the Title 20/24 or standard practice conditions relevant to the affected normal replacement measure and provide proof that the implemented measures exceed these requirements. The IOU savings claim should be consistent with this logic.
- The IOUs should use the CPUC definition of peak demand, if the assessment of peak demand remains an important part of the impact evaluations.
- The CPUC and all IOUs should establish a series of rules for inclusion of indirect measures in the savings claim for future program cycles where indirect savings are claimed. The utilities should also reconsider whether savings claims should be made at all for indirect measures like audits. The results from this evaluation indicate that the utilities do such a good job of directing audited customers to the financial incentives offered by the direct programs that there are minimal indirect savings to be claimed.
- The programs should get involved with projects at the earliest possible stage.
- The programs would benefit from early project net-to-gross and baseline screening of the largest customers to eliminate incentives to participants who are clearly going to take action without the program.

2.2.5. Commercial Facilities Evaluation

PGE's High-Tech and Large Commercial energy efficiency programs were offered during 2006-2008 to high tech and large commercial customers to provide assistance with the installation of energy efficiency technologies. High-tech programs focused primarily on data centers, laboratories, and biotechnology facilities, with secondary targets that included clean rooms, office space, and telecommunications centers. The Large Commercial program focused on providing a range of cost-effective energy efficiency program elements to customers for whom capital expansion, capital renewal, and/or operations and maintenance products and services were procured through contracts with manufacturers and/or distributors.

The evaluation examined PGE High-Tech and Large Commercial energy efficiency programs, as well as energy savings from strip curtains and door gaskets in supermarkets and refrigerated warehouses in PGE, SDGE and SCG services territories. The evaluations estimated gross and net kWh, kW and therm impacts for the 2006-2008 program years. Evaluation work included site visits to over 300

buildings, approximately 300 phone interviews and surveys, and on-site metering and measurement at over 400 locations.

Findings

- For the PG&E Hi-Tech Program, the greatest factor impacting the gross realization rate was the failure of some very large projects to be built out to the full capacity as initially intended when the application was submitted. The net-to-gross ratio was much lower than expected because the projects were initiated by the customer and would have proceeded without the incentive program. On the other hand, customers acknowledged that PG&E played an important role in providing technical information and validating the potential impacts for the projects.

- For the PG&E Large Commercial program, the greatest factor impacting the gross realization rate was inadequate documentation and inappropriate determination of the baseline conditions. The net savings was slightly lower than expected due to an increasing awareness of global warming issues and the need for the participant sites to be "green" which led many of the survey respondents to state that the projects would have happened without the effect of the incentive program.

- For strip curtains, the greatest factor impacting the gross realization rate was that the duration that the door into the refrigerated compartment was open was much lower the ex ante estimates. The net savings was much lower than expected due to the fact that many sites implemented maintenance programs which maintained the door gaskets on a regular basis.

- For door gaskets, the greatest factor impacting the gross realization rate was the determination that even old, seriously degraded door gaskets perform very well, causing the baseline to have a much lower infiltration rate than the rate documented in the IOU work papers. For example, one of the IOU baselines assumed that each gasket had 44 square inches of open space per door whereas the baseline study determined that the actual value was less than 1.5 square inches. The net-to-gross ratio was much lower than expected due to the fact that many sites implemented maintenance programs which maintained the door gaskets on a regular basis.

Recommendations

PGE High-Tech and Large Commercial

- Documentation, justification and supporting data for the base case equipment on which claimed savings are based needs to be improved.

- More rigorous review of very large projects, including additional pre- and post-retrofit measurements undertaken to ensure sufficient data on which evaluators may base their savings calculations.

- The selectivity of eligible projects should be increased by identifying market segments and other project qualification criteria that encourage projects with

marginal cost-effectiveness that in the absence of the incentive would not be implemented, to move forward.

Strip curtains and door gaskets

- Baseline assumptions used to determine savings should be revised and the procedures used to determine site eligibility should be improved.
- Documentation of the baseline equipment efficiency for the refrigeration unit and surrounding spaces also needs to be improved.

2.2.6. Government Partnerships Evaluation

The Local Government Partnerships grouping involved a wide range of custom-type lighting and HVAC projects implemented in the University of California and California State University, and California Community College systems. Additionally, the commercial and residential offerings provided by the Palm Desert partnership were part of the program.

In order to maximize the use of evaluation resources, a limited number of partnership programs were evaluated. The evaluation covered UC/CSU and CCC programs focused on retrofit projects, while the evaluation of the Palm Desert Partnership program focused on three key measures (residential/commercial RCA and residential early HVAC retirement). The field work involved 284 NTG surveys, 139 sites metered, and 944 data loggers deployed.

Findings

UC/CSU

- Low gas realization rates for custom HVAC projects (i.e., 0%) were generally attributed to incorrect baseline assignments. For example, the *UCD – Centrifugal Chiller Retrofit* project involved fuel switching and the normal replacement of absorption chillers. However, because the project was incorrectly characterized as a retrofit in the project application, gas savings were not realized. Instead, savings for the normal replacement centrifugal chillers were limited to the savings exceeding the Title 24 equivalent for the same fuel type. This project accounted for over 50% of the impact evaluation samples claimed gas savings.

CCC

- The analysis indicated that while the realization rates for lighting measures were reasonably high (between 49% and 98% across the IOUs, with most in the higher range), the realization rates for HVAC measures were noticeably lower (most between 26% and 40%, with one exception). However, the HVAC measures analyzed were generally part of broader, campus-wide energy efficiency projects often involving changes to a campus's central plant. Such projects generally take some time to plan and often had not been fully completed by the end of the 2006-2008 program cycle. For example, a retrofit project may have been planned for central plant HVAC equipment that served several buildings, but only some of those buildings were being serviced during the evaluation period.

The differences in gross and net realization rates across IOUs can also be attributed to differences in the mixes of lighting and HVAC projects. An IOU program with a greater percentage of lighting projects generally showed higher realization rates.

Palm Desert Partnership Programs

RCA realization rates were found to be exceedingly low as a result of the following primary factors:

- Claims of substantial savings were made where there was either no documentation or the documentation was insufficient to determine what actual field implementation of program measures occurred. For example, some installation forms had no indication that the coil had been cleaned, no indication of a change in refrigeration pressure, and no indication of a refrigerant charge treatment. The evaluation team recognizes that this could be a documentation issue, although anecdotal evidence also supported that in many cases there appeared not to have been any refrigerant charge adjustment. As another example, some forms indicated in the notes that the coil had not been cleaned. The evaluation team did give savings credit to sites where there was an indication of a change in refrigerant pressure even though there was no documented refrigerant charge adjustment.
- From the available documentation, there was little evidence that substantial improvements were made for most sites.
- A significant fraction of the units in the sample had either been replaced or had had significant repairs made including refrigerant charge adjustments after participation in the program.
- Overall, the documentation of on-site actions and measure implementations did not provide sufficient information to provide for a robust technical analysis of savings.
- The relatively low realization rates of the early retirement program were primarily a result of low net-to-gross ratios. The customer population in Palm Desert is comprised to a significant extent of people who are primarily winter residents (e.g., snow birds). Participation by winter residents has the effect of diminishing average peak demand savings and summer cooling energy savings.
- Free-ridership in Palm Desert was found to be moderate with NTG ratios ranging from 0.69 for Residential HVAC/ER, to 0.85 for All Commercial Measures Excluding RCA. The following factors may help explain the high free-ridership:
    - The program had aggressive goals, high incentive levels, and significant marketing efforts, with high market penetration. High incentive levels and aggressive marketing of high incentive levels can lead to increased free-ridership.
    - The Commercial Program appears to have slightly less free-ridership than the Residential. This could be attributed to the fact that Commercial customers base decisions on financial results, and thus decisions are more likely to be directly attributable to incentives. In the Residential sector, customers' decisions can be less responsive to incentive amounts, and many customers may have decided to implement a measure regardless of incentives.

Recommendations

UC/CSU

- Participant data requirements should be standardized;
- Normal replacement vs. retrofit classification should be carefully classified;
- Differentiation between gross and peak demand estimates should be clear.

CCC

- Improve the accuracy of ex ante lighting operating hours estimates;
- Consider long project completion times in estimating savings for complex HVAC projects.

Palm Desert

- Improve the documentation of RCA measures;
- Provide higher level of oversight and QC of installation contractors;
- Focus early HVAC retirement efforts on permanent, year-round residents.

2.2.7. Non-Residential New Construction Evaluation

Each of the IOUs operates non-residential new construction programs. SCE, SDGE, and SCG operate similar Savings by Design (SBD) programs. PGE groups its programs under market segments, but for this non-residential new construction evaluation they created a "virtual" Savings by Design program for the commercial sector as a whole. The group includes a sub-group of several smaller programs that are aimed at testing new applications or improving efficiency among a relatively small target population. Industrial and Commercial projects are paid an incentive for participation in the Savings by Design program.

Findings

- The evaluation determined that the IOUs' non-residential new construction programs continue to provide large gross savings, with a substantial fraction being net savings despite changing codes and baselines. The positive performance was especially true for Savings by Design as it is applied to whole buildings.
- This evaluation also illustrated that for gas measures, the ex-ante assumptions were either difficult to estimate or not estimated correctly.
- For specific projects, gross savings realization rates can vary widely, especially if they involve gas measures.

- Gross savings can vary widely due to many issues, but several of them were within control of the utilities:
    - Ex-ante baselines assumptions can be set erroneously
    - many assumptions and calculations are undocumented in the IOUs' files, leaving unexplained differences with ex-post results
    - some measures were listed in the tracking system with significant savings but were never installed; and
    - some measures were installed, but clearly did not perform properly.

Recommendations

- The IOUs should continue the SBD program as it provides value to customers and provides significant energy savings.
- When the program was provided to industrial sites, which offer significant opportunities for gross savings, the program seemed to present opportunities for significant free-ridership.
- IOU implementers should exercise more care and due diligence to ensure the standard practice efficiency envelope is fully-leveraged when SBD is applied to industrial facilities.
- We believe the utilities need to improve the tools they are using to determine natural gas savings estimates.
- The IOUs need to improve their program implementation Quality Control to minimize the instances that results in implementation activities that vary significantly from the design assumptions.

2.3. Industrial and Agriculture Evaluations

2.3.1. Southern California Industrial and Agricultural Evaluation

This evaluation focused on two high-impact measures – steam traps and pipe insulation -- and also evaluated pump tests offered under the Southern Cal Edison Agricultural Energy Efficiency Program as well as projects implemented under the SCE Industrial Energy Efficiency Program.

Steam Traps

Steam trap evaluations were conducted in PGE, SCG and SDGE service territories and were divided between small commercial and industrial applications. The small commercial savings were evaluated by IOU while industrial evaluations were split between "low pressure" and "high pressure" traps. Agricultural pump tests performed under the Southern Cal Edison agricultural energy efficiency program [SCE 2510] were also evaluated. Additionally, projects in the SCE industrial energy efficiency program [SCE 2509] were evaluated. Evaluation work included approximately 140 site visits and over 1,400 interviews.

The realization rate for commercial steam traps was quite low, while the realization rate for industrial installations was fairly high.

Findings

- Commercial billing analysis for steam traps yielded realization rates that were lower than anticipated. Previous evaluation results were based on an analysis that restricted analyzed sites to those that did not experience an increase in gas usage following the installation of steam traps.
- For industrial steam traps, 14 percent of sites visited had zero savings, while 12 percent of sites visited had realization rates over 400%.
- Reasons for zero savings include: all rebated traps failed/closed; boilers were not functioning; sites were not operational; sites did not use utility natural gas to fuel boiler
- Reasons for high realization rates include greater pressures and operating hours than those assumed in work papers.

Recommendations

- Industrial steam traps should not be a prescriptive technology but rather rebated as a custom technology.
- IOUs should closely monitor rebated steam traps to ensure proper installation and operation.

Pipe Insulation

The realization rate for pipe insulation was extremely low.

Findings

- A high incidence of installations did not qualify for participation under program rules (pre-existing insulation or new construction)
- Assumed industrial operating hours used to estimate impacts of insulation installed on pipe greater than or equal to 1" diameter were inconsistent with evaluation results that determined insulation installed on such piping was actually in commercial facilities with substantially shorter operating hours.

Recommendations

- Controls should be instituted to ensure compliance with program guidelines
- Revisions should be made to the Pipe Insulation Work Paper assumptions and ex-ante impact claims.

Pump Tests

Pump testing is part of Southern California Edison's (SCE) Agricultural Energy Efficiency Program (SCE 2510). There were no claimed savings for this measure with any other 2006-2008 IOU energy efficiency program. In terms of the study approach, a participant self-report survey was implemented to collect data used to evaluate the gross and net impacts of a pump test through SCE's Ag Program.

Findings

- Tracking records had lower gross impacts than the assumed average gross impact per completed repair.
- This evaluation found that only 20 percent of pumps in need of repair go on to be repaired, and customers reported that 66.4 percent of the pumps repaired did not go through a program where incentives are paid.
- Thus, only 8 out of every 100 pump tests result in a repair and some associated level of impact.

Recommendations

- On-site verification of pump operating efficiency (kWh, kW) should be performed.
- Future evaluations should look for ways to encourage participants to follow through with repairs, as this evaluation found that only 20 percent do so.

SCE Industrial (SCE 2509)

A site-specific engineering approach was used for this evaluation. However, due to the shift to measure-based evaluation, the impact evaluation results were based on a very small sample size.

Findings

Low realization rates (gross and net) are attributable to:

- Poor baseline specification used to calculate ex-ante savings.
- Reductions in operating hours and reduced equipment loading due to recession.
- Unverified and undocumented assumptions were used as inputs for the savings calculations for many applications.
- Some measures were found to be standard practice, e.g., POC installations on new wells.
- Program implementers arrived late in the decision making process and offered incentives for projects that had already been decided upon.

Recommendations

- Improve baseline specifications by explicitly identifying whether a project is replace-on-burnout, natural turnover, or early replacement.
- Program staff should make more conservative assumptions for calculating project savings.
- Programs should increase levels of real-time measurement and pre- and post-installation measurement-based verification, especially for large projects or those with uncertain savings.
- Consider limiting or excluding incentive payments to known free-riders.

2.3.2. PGE Fabrication, Process and Manufacturing Evaluation

This evaluation focused on one core PGE program and nine third-party programs for the 2006-2008 energy efficiency program cycle. Based on the magnitude of the claimed savings, the group of programs was divided into technology groupings for developing and reporting evaluation results. These groupings were: oil well pump off controllers (POCs), all other electric measures ("non-POC electric"), and gas measures. Evaluation work included approximately 130 site visits and over 300 interviews.

Findings

The evaluation found low realization rates for kW, kWh, and therms attributable to:

- Poor baseline specification, predominantly existing *in situ* equipment used to calculate ex ante savings.
- Some projects did not qualify for rebates.

- Unverified and undocumented assumptions were used as inputs for savings calculations.
- Some measures were found to be standard practice.
- Program incentives were offered for projects being implemented in response to mandates from other regulatory agencies (e.g. air resource districts).

Recommendations

- Improve baseline specifications by explicitly identifying whether a project is replace-on-burnout, natural turnover, or early replacement.
- Program staff should make more conservative assumptions for calculating project savings.
- Programs should increase levels of real-time measurement and pre- and post-installation measurement-based verification, especially for large projects or those with uncertain savings.
- Consider limiting or excluding incentive payments to known free-riders.

2.3.3. PGE Agricultural and Food Processing Evaluation

The evaluation estimated gross and net kW, kWh and therm savings from the PGE Agriculture and Food Processing Program. It also evaluated greenhouse infrared film and greenhouse heat curtain measures in PGE, SDGE and SCG service territories. Evaluation work included on-site data collection at over 80 customer facilities and approximately 130 telephone surveys.

PGE Agriculture and Food Processing

Findings

Low realization rates are attributable to:

- Differences between ex-post and ex-ante savings are attributed to a number of factors, including incorrect baseline assumptions, regulations, codes, or industry standards that were not accounted for, and the use of inaccurate baseline parameters.
- Differences between ex ante model assumptions and actual on-site greenhouse characteristics (for infrared film technology).

Recommendations

- For PGE Agriculture and Food Processing, the accuracy of ex-ante estimates should be improved. Additionally, more accurate evaluations require improved documentation, justification, and supporting data for the base-case equipment on which savings are based.

- More pre- and post-retrofit measurement on large projects is necessary to ensure there is sufficient data on which evaluators may base savings calculations.

Greenhouse Measures

- The primary reason for the low realization rates for the infrared film and heat curtain measures was differences between ex ante model assumptions and actual on-site greenhouse characteristics. Specifically, the installation of under-bench heating systems rather than unit heaters in the evaluated greenhouses led to lower temperature stratification assumptions in *ex post* models. Additionally, although it was not clear what the temperature set points were in the *ex ante* impact calculation, in those greenhouses with low temperature set points (58-62°F) and no summer heating, the *ex post* measure impacts tended to be lower than the *ex ante* impacts.

Recommendations

- For greenhouse technologies, the models in use to calculate ex-ante unit savings need to be updated.

2.4. Codes and Standards Evaluation

The four IOUs implemented similar, coordinated programs to support upgrades of the Title 20 Appliance Efficiency Standards (T20) and Title 24 Building Energy Efficiency Standards (T24). The IOUs have claimed energy savings and demand reduction based on their contribution and support activities to the adoption of these codes and standards. These programs contributed to the adoption of energy-efficiency building codes and appliance standards that went into effect in California between late-2005 and the end of 2008.

Findings

The C&S Program, through its activities prior to 2006, produced significant verified energy savings during the period 2006 through 2008. In general, the verified electricity savings are slightly more than the claimed savings, while the verified demand and natural gas savings are less than the claimed amounts. Building energy use was modeled, but no metering was conducted as part of this evaluation. Overall, the Program has made a significant contribution toward energy savings in both buildings and appliances.

Recommendations

- Continue to identify and target both appliance and building standards with large potential energy savings. The overall program has been successful and cost effective and focusing on areas where standards have the potential to provide the largest savings makes good sense.

- Assess thoroughly the current market penetration of efficient technologies and measures and trends in naturally occurring market adoption and focus efforts on standards where penetration and market adoption are likely to be the smallest. Conduct research to improve market characterization for appliances and measures considered for new standards. Additional savings from some of the standards in the last round were reduced significantly because the penetration of the efficient appliance or measure was already quite high and natural adoption was expected to increase to high levels in a relatively short time.

- Move toward an assessment of savings potential based on a reliable estimate of average efficiency in the existing market to establish the baseline for appliances. To date, most analyses of likely savings from new standards were based on point estimates of energy efficiency. A more accurate approach would be to determine the average baseline efficiency level and the likely distribution of efficiencies and the new average once the proposed standard is adopted.

- Fully integrate a process of increasing codes and standards compliance and enforcement into the overall C&S Program approach. Some efforts are being directed at increasing compliance and the effectiveness of the Program would benefit from a comprehensive strategy defining and implementing a range of compliance and enforcement activities.

- Work with the CEC to develop protocols for assessing appliance standard compliance and develop approaches to increase compliance with standards where

the rate is low. Compliance with some of the appliance standards was determined to be relatively low in the current evaluation so achieved savings were reduced substantially. The CEC has not been very actively involved in enforcement of its appliance standards so IOU activities in these areas could be very beneficial.

- Continue coordination of the Program among the utilities to leverage resources and expertise. The IOUs have each developed specific roles and areas in which they have contributed through the statewide C&S Program. This has been very effective and has made good use of the IOU resources.

- Articulate, communicate, and implement a comprehensive strategy linking DSM programs and activities to the C&S Program and long-term goals for standard adoption. The emerging technology and specific DSM programs are part of a continuum that provides the basis for new standards. The IOUs have described this process in the past, but a more comprehensive articulation of this approach could help define it better for purposes of long-term planning and recognition of the contribution of the C&S Program by the CPUC.

- Collaborate with the CEC, associations of local governments and code officials, and the legislature to ensure that the enforcing entities collect and retain the documentation used to verify Title 24 compliance. In particular, policies need to be implemented to ensure code compliance documentation is retained. IOUs should work more with local jurisdictions and provide training to enforce the code.

- Encourage local jurisdictions to adopt reach codes and document the data needed to assess compliance. The Strategic Plan emphasizes the role of reach codes as the basis for the next round of building codes and appliance standards and this will be more effective if the IOUs support local jurisdictions in the adoption, implementation, and verification of compliance with the codes.

- For buildings, assess proposed changes to the standards in terms of whole building impacts. Historically, measures covered by the standards have been analyzed largely in isolation, but the measures can typically be traded off for other measures when a building is built so the savings may not be exactly the predicted amount and interactions with other measures are possible. Examining proposed standards from a whole building perspective would provide a better understanding of likely impacts. The whole-building analysis approach does pose challenges by requiring more complete building information and modeling; however it treats the impacts of the building standards more realistically and accurately, particularly when compliance is not strictly prescriptive as is usually the case in California for both residential and nonresidential buildings.

- Support research to determine the effects of the TDV methodology and verify that it is having the projected effect on building design, construction, and performance.

- Undertake research to better align energy usage predictions from the compliance software with actual energy usage. Differences between predicted and actual energy use have been noted in the past and it is possible savings predicted by compliance software misestimates actual savings significantly. If estimates are

worse for certain measures, building components, or equipment, these should be identified and efforts taken to modify the software to provide more accurate estimates.

- Continue working at the federal and national level to promote new building and appliance standards. The IOUs have expanded their efforts in these areas and they continue to have a payoff in the area of appliance standards that are preempted by federal regulations and building efficiency measures focused on by ASHRAE, DOE, and other organizations.

2.5. Non-Resource Programs

2.5.1. Third-Party Education and Information Evaluation

The evaluation assessed 19 programs from the four IOUs. Nine of these programs were fully evaluated for indirect impacts[43], while the other ten were verified due to discontinuation after or during the 2006-2008 program cycle. The primary goal of the programs is customer exposure to information on saving energy in order to generate behavior change. The indirect impacts of this campaign were determined by measuring: (1) program reach, (2) knowledge increases, (3) behavior changes, and (4) energy savings from behavior change. Evaluation work included 1,270 completed surveys out of a sample size of over 15,000 program participants for all nine programs.

Findings

***Program Reach*:**

- The reach and intensity of programs varies greatly, and these programs tend to show an *inverse relationship between reach and intensity*. The intensity of information can be valuable at low and high levels depending on the type energy efficiency knowledge that a program intends to impart.
- The evaluation also found that participants often shared program information with friends, family and colleagues, *extending the reach of these programs beyond the number of direct program participants*.
- Education and Information programs targeting mid-stream market actors have a strong multiplier effect in the market by transferring information to their clients as well as influencing the energy use of many buildings.

***Knowledge Increase*:**

- Residential market participants reported very large energy efficiency knowledge increases ranging from a high of 56% of SCG PACE[44] Energy Efficiency Outreach participants to a low of 37% among Time of Sale participants.
- In the commercial sector, 60% of SCG PACE participants reported very large energy efficiency knowledge increases, while 24% of SDGE Business Energy Assessment participants indicated a very large change.

***Behavior Change*:**

- The programs *were successful* in getting participants to take action.

[43] Indirect impacts are energy savings achieved through the actions of the customers exposed to a program's efforts, without direct enrollment in a program that has energy savings goals.

[44] Pacific Asian Consortium in Employment.

- Among commercial participants, 83% of commercial SCG PACE participants and 65% of SDGE Business Energy Assessment participants took action, with the most frequent actions including lighting upgrades and refrigerator replacement.

- The percent of residential participants that installed an energy efficient measure ranges from a high of 87% among SCG CLEO[45] participants to a low of 70% among SDGE Time of Sale participants, and focused primarily on the installation of CFLs and low-flow showerheads.

- The percent of market actor participants that recommended energy efficient measures to their residential clients ranges from a high of 97% to a low of 83%. The most frequent actions taken by their residential clients include upgrading lighting and duct systems.

***Energy Savings*:**

- Estimated program savings ranged from 53 to 16,950 MWh, for a total of 33,000 MWh and 2 million therms net annual savings across all programs (savings equaling approximately 26,992 metric tons CO_2 reduction).[46]

- A case study for SCG Portfolio of the Future indicated a potential savings of 27 million therms from one of the measures folded into the energy efficiency portfolio.

As Education and Information programs, the nine programs covered by this evaluation effort had no explicit energy savings as part of their goals. Nevertheless, energy savings (albeit small) are occurring as a result of these programs. However, the larger value of the programs lies in their role in the overall marketplace. The evaluation shows that these programs play other important functions including:

- channeling customers to rebate programs;

- contributing to socially equitable access to energy efficiency information;

- intervening in the marketplace at the optimal point in time;

- accelerating market adoption of new energy efficient technologies.

Recommendations

- Determine where Education and Information programs are needed to achieve each sector's goals in the Long-Term Energy Efficiency Strategic Plan for California; set realistic expectations for new programs by acknowledging program ramp-up time; consider that programs designed to target market actors have the potential to touch more individuals due to the multiplier effect.

[45] Custom Language Efficiency Outreach.

[46] Note that this is for one year, not lifecycle savings.

- Base success metrics on the role each program is expected to play; evaluate these programs under the sector (e.g. residential, commercial, etc.) that the program is addressing, this is pertinent for future EM&V efforts; allow evaluators to directly contact third parties to collect program information.

2.5.2. Statewide Marketing and Outreach Evaluation (SWMO)

The evaluation included three program components (Flex Your Power-General including an ethnic subcomponent, Flex Your Power-Rural, and Flex Your Power-Spanish), united as a single comprehensive umbrella campaign to educate Californians about energy efficiency and raise awareness and knowledge of energy saving actions to promote behavior change. The indirect impacts of this campaign were determined by measuring (1) exposure to the program, (2) changes in awareness and knowledge, (3) changes in intent to take action and in behaviors as a result of the program, and (4) potential energy savings as a result of the behavior change. Evaluation work included 7,000 completed surveys.

Findings

Exposure and Reach:

- The reach of the program is fairly high (9.5 million of approximately 12 million IOU households), with the greatest reach occurring among English speakers.
- The primary method of outreach (mass media through 10- and 30-second spots) limits the intensity of the information communicated.
- The frequency of exposure was less than the stated goals.
- There is a statistically significant relationship between frequency of exposure and message awareness and recall.[47]

***Awareness and Knowledge*:**

- The greatest effects of the program can be traced to increases in consumer awareness and knowledge.
- The most notable effects of the program include changes in top of mind awareness of ways to save energy in the home (10% to 15% increases depending on the population), consistent with the intent of the program.
- Spanish and Asian-language speakers' composite change in knowledge was substantially greater than among English-speakers, likely due to lower levels of intervention in these communities in the past. This indicates that the current mass media and outreach methods were more effective during this program cycle for these audiences compared to English speakers.

[47] People exposed to FYP four or more times had a 9% higher recall of the FYP name than those exposed less than four times.

Intent to Take Action and Behavior Changes:

- There were small but significant changes in both intent to purchase a CFL and the actual behavior of purchasing CFLs.

***Energy Savings*:** The evaluation estimated energy savings based on CFL purchases resulting from exposure to messaging.

- The program is having a small but statistically significant effect on the intent to take action and behavior change related to CFLs.
- This effect is equivalent to roughly 175 GWh of annual savings from CFL purchases (equivalent to approximately 10% of the gross savings from the PY2006-2008 Upstream Lighting Program).
- The avoided carbon dioxide (CO2) emissions from the estimated GWh savings are 86,000 metric tons annually.[48]

Savings were due, at least in part, to the influence of the SWMO program. Notably, however, while the campaigns focused on several actions (installing energy efficient HVAC and appliances, etc.) the evaluation efforts to determine savings looked only at CFLs. Thus, total savings due to the SWMO program are expected to be greater.

Recommendations

- Program design recommendations: (1) create clearly defined program goals and performance metrics in program planning documents prior to implementation; (2) review messaging in the market prior to developing goals, and determine whether program efforts should enhance existing messages, complement existing messages, or fill a void in messaging; (3) de-emphasize mass media as the primary element in the SWMO program; and (4) refocus efforts on initiatives that are highly localized and targeted with the capacity to provide detailed information about energy efficiency or conservation measures.
- EM&V recommendations: efforts should be based on multiple success criteria that measure both the behavioral impacts of the SWMO efforts as well as the intermediate effects gained through program outreach, such as increases in awareness, knowledge, attitudes, intention, or decreases in barriers. In addition, the CPUC, IOUs, and the program implementer should develop and agree on common metrics and success criteria so that the implementer has a clear target. Future EM&V efforts should also consider utilizing quasi-experimental methodologies, which are uniquely suited to tease out the effects of the SWMO from other market influences.

[48] Note that this savings estimate does not attempt to pull out the effects of the Upstream Lighting Program since respondents are not knowledgeable about effects that occur upstream.

2.5.3. Statewide Energy Efficiency Education and Training Evaluation

The evaluation assessed the indirect energy efficiency impacts of nine Energy Centers -operated by the four IOUs during program years 2006-2008. The evaluation of these Energy Centers involved numerous research and data collection tasks including in-depth interviews, review of program materials, quantitative surveys, and an engineering analysis of survey results.[49]

The primary goal of the program's intervention is exposure to information about energy-efficient technologies and practices that increase knowledge and generate behavior change such as reducing energy usage, lowering utility bills, reducing operation and maintenance costs, and improving productivity. The evaluation (1) assessed the reach of the program, (2) identified changes in knowledge of energy efficiency, (3) sought to understand the behaviors that resulted due to the program, and (4) quantified net energy savings for key components of the programs. Evaluation work included 7,700 completed surveys out of a sample size of approximately 35,000 participants.

Findings

Reach of the Centers:

- The nine Centers offered 840 unique courses, which totaled 547,560 hours of training and reached over 39,000 unique attendees.
- Just over half of the unique attendees were market actors (55%), followed by commercial end-users (30%) and residential end-users (15%).
- The Centers touched an estimated 20,000 market actors, over 12,000 commercial end-users, and nearly 6,000 residential end-users.

***Knowledge Change*:**

- Over 95% of training participants self-reported gains in knowledge that moved them closer to implementing efforts to save energy.
- Most participants cited a moderate increase (ranging from 40-47% depending on the type of participant) or large increase (ranging from 40-48%) in knowledge.
- The courses were effective at increasing knowledge among all course participants regardless of the amount of prior knowledge they had of the course concepts or the type of course that they took.

***Behavior Change*:**

- Almost four out of five (77%) commercial respondents took actions to save energy at their facilities.
- Two out of five (43%) residential end-users took actions to save energy in their homes as a result of the course(s) they took.

[49] No onsite data was collected, as this evaluation was only required to meet a standard level of rigor by the protocols.

- 70% of market actors indicate that they changed or enhanced the services they provide to clients using concepts learned in the courses.
- The top three areas where market actors took action varied by group but tended to include building envelope, HVAC, and lighting, which is consistent with the areas in which the majority of courses were offered.
- For the residential end-users who took action, the majority of changes were related to solar energy, followed by building envelope, HVAC and lighting.
- Commercial end-users show similar results in terms of subject focus with changes occurring primarily in HVAC, lighting, and building envelope.

***Energy Savings*:**

- The Energy Centers' combined yearly gross impact was estimated at 700 GWh with a net impact of 544 GWh.[50]
- The Centers are also responsible for annual gas savings of approximately 6 million net therms.

The Energy Centers also focused on providing courses to market actors. However, the energy savings associated with market actors varies widely. Two of five market actors (43%) stated that the changes they made because of the Energy Center course resulted in measurable energy savings for their clients, with 15% classifying the savings as "significant." The evaluation found that over 10 GWh of savings were attributable to the actions taken by 29 market actors who participated in in-depth analysis as a result of the courses taken at the Energy Centers. The average savings per market actor was 0.36 GWh, although there was significant variation as demonstrated by the median value of 0.011 GWh. While this number should not be extrapolated to all market actors and may be partially accounted for through the impacts of rebate programs,[51] it gives some insight into the possible energy savings associated with those market actors that revised their practices as a result of taking an Energy Center course. These programs also play other important functions that cannot be captured in terms of kWh or therms, such as:

- channeling participants into IOU programs;
- providing continuing education for those already in the workforce;
- providing cutting-edge information directly to building operators;
- reducing barriers to energy efficiency through customized training;
- catalyzing the market transformation of efficiency products;
- training-the-trainers; and

[50] Overall, the portfolio of programs was estimated to save approximately 10,500 net annual ex ante GWh. The net savings from the Centers provides an additional 5% to the overall projected energy impact. The net impacts for end users are comparable to other resource acquisition sectors. Note that these values do not account for what are perhaps significant additional savings from market actors

[51] It is possible that some energy savings associated with course-inspired practice changes made by market actors have been accounted for in the impact assessments of the rebate programs offered by California IOUs.

- creating and environment for networking and community collaboration.

Recommendations

Program design recommendations:

- Clearly identify program goals and performance metrics and ensure that these are agreed upon by both the utilities and the CPUC prior to the program cycle.
- Regularly review results to inform future program design.
- Improve program tracking by: creating a common registration form used across all nine Centers, using consistent data entry for course and participant tracking, creating a shared registration system across the nine Centers, and if possible, assigning a unique identification number to each participant.

Future EM&V efforts should:

- Measure participant knowledge and behavior change on an ongoing basis.
- Include questions on decision making and other demographic and firmographic information.
- Implement different research designs for end-users and market actors, and
- Focus on market actors.

2.5.4. Government Partners Non-Resource Evaluation

This study set out to determine how effective local governments are at using their unique channels to motivate behavior change among community members. It estimated energy savings due to actions motivated by non-resource program elements such as audits and trainings. So as not to double count savings, this evaluation estimated indirect impacts not derived from resource acquisition programs, such as the installation of non-rebated measures recommended in an audit. A lack of basic record keeping (name of participant and phone number) prohibited the evaluation of more than 80% of the efforts originally planned. Indirect savings estimates could only be made for trainings and audits, due to a lack of information on referrals.

The lack of record keeping and performance targets found here is problematic given the apparently significant expenditure on these tasks among local government partnership contracts.

Findings

The evaluation found varying levels of success at the partnership program and program element (audit, training, referral) levels.

- Between 27% and 90% of participants took an energy saving action, depending on the program.
- Evaluators believe this mixed success is due to the nascent nature of the program activities, as the efforts for the 2006-2008 program cycle mark the first time LGPs were recruited to develop and deliver programs on such a large scale, traditionally not within the purview of local governments.

Audits

- Average indirect annual energy savings per household ranged from 89-100kWh, .01-.03kW, and .19-6.7 therms.
- Average indirect annual energy savings per business were 157kWh and .05kW.
- Limited indirect energy savings resulting from the residential, small commercial and government facility walk-through audits suggest that the audit process needs to be more effective, perhaps providing participants with a richer experience.
- City government staff attributed their motivation to move forward with projects to in-depth information such as the cost-benefit analysis and investment-grade audit provided by the Association of Bay Area Governments.

Trainings

- Average indirect annual energy savings per non-residential participant were 23,153kWh, 6.7kW, and 121 therms.
- Overall, almost all respondents across three types of trainings reported that the workshops provided them with new information (95% of 185 surveyed). In addition, responses indicated the trainings positively impacted respondents' ability to understand and identify energy efficiency opportunities. This was true for all types of respondents: residential, non-residential, and market actors.
- Increased understanding and/or awareness of energy efficiency opportunities was shown to be correlated with the likelihood that the participant has made an effort to save energy at their facility. These informed actors attributed the workshop(s) they attended with influencing them to make an energy saving effort.

Referrals

Data was too limited to address all of the researchable issues for this mechanism. However, the evaluation did determine that:

- The referrals process is currently not successful in getting customers what they need to participate in an appropriate resource program. Customers were often not aware they had been referred and there was no follow up. Many partnerships indicated

they were not tracking or managing a referral system. There was also a variety of definitions of and methods used for referrals.

- Evaluators recommend setting quantitative goals for referrals, and tracking progress toward them.

Recommendations

- Participant data is imperative in order to follow up with participants who were referred to a resource acquisition program, or received an audit. (These data needs were outlined in the 2006 California Energy Efficiency Protocols.)
- The level of engagement of program staff is important in determining the effectiveness of a non-resource element.
- A coordinated effort is needed to refine the definition of and present exemplary practices for referrals and other non-resource elements that local governments are employing.
- Programs need to track key, affordable performance metrics such as the percent of participants who purchased energy efficiency equipment as a result of an audit, percent who changed their behavior, or percent who acted on a referral to a resource acquisition program.

2.5.5. Statewide Emerging Technologies Program (ETP) Evaluation

The Emerging Technologies Program evaluation included process and impact components and focused on four overarching goals: 1) Evaluability Assessment, 2) Program Design Assessment, 3) Program Implementation Assessment, and 4) Impact Assessment. The evaluation was designed to comprehensively assess the ETP across multiple dimensions and the various research tasks were scheduled in a staggered manner that allowed the results of initial tasks to inform the development and focus of subsequent tasks. In addition, two interim reports were also prepared to provide early feedback to ETP managers. Finally, many of the key findings reported, often supported by more than one element of the evaluation, can be divided into high level successes and challenges.

Findings

High-level successes include the following:

- The design of the ETP as implemented during the 2006-2008 program cycle was plausible and the implementation processes developed by the utilities were consistent with the broad program intentions outlined within the corresponding Program Implementation Plans.
- ETP staff had acted on recommendations made in prior program evaluations and were striving to meet their goals in terms of number of completed technology assessments and other metrics established by ETP managers and the CPUC.

- The ETP has generated multiple projects that produced technologies that were transferred to energy efficiency (EE) programs. PGE's transferred ETP technologies had generated approximately 59 GWh of *ex ante* expected first-year gross savings and SCE's transferred ETP technologies had generated approximately 196 GWh of *ex ante* expected first year gross savings. While ETP technologies were recommended for consideration as EE program measures, no activity for transferred ETP technologies was recorded in Sempra EE program tracking system data for the period 2006 –2008.

Challenges to ETP performance during the 2006-2008 program-cycle include the following:

- The ability of the ETP to help EE programs achieve energy and demand impacts has been compromised by lack of feedback between the ETP and the EE programs to which technologies had been transferred.

- Documentation of useful technical potential estimates, a critical element in technology selection, was present for only 36% of sampled ETP projects. This is consistent with other aspects of the evaluation that highlighted the need for improved documentation of ETP decision-making and implementation processes (e.g., migration of projects through the ETP phases).

- The effectiveness of the Emerging Technology Coordinating Council (ETCC) is reduced due to a lack of formality at Emerging Technology Coordinating Council (ETCC) meetings hinders ETP staff's ability to document decisions made during the meetings and track subsequent actions taken on specific discussion topics

- ETP stakeholders were concerned with the utilities' focus to achieve energy and demand impact goals for each three-year program cycle, Utility staff tended to expect the ETP to meet their more immediate need for new technologies at the expense of technologies that have significant savings potential but might require a longer time to assess. This short-term focus compromises the ETP's ability to support the statewide strategic goals.

- The evaluation was hindered by a lack of consistent, well organized project data.

- The degree of scientific rigor applied to the peer-reviewed ETP projects varied considerably from one project to another—even within the same utility. This diversity in rigor appears to reflect a diversity of understanding and opinion among the ETP project managers regarding the fundamental goals and underlying theory of the ETP.

Recommendations

- Improve quality and consistency of documentation of program processes, procedures, and corresponding decision-making (e.g., technology selection and transfer decisions, technology migration through the ETP).

- Expand use of interdisciplinary project teams, one of the hallmarks of successful product development efforts, to improve technology selection processes and increase the likelihood that candidate technologies will succeed in EE programs as well as in the broader market.

- Develop more robust technical and market potential estimates, as well as enhanced market research, for technologies being considered for inclusion in the Program to help prioritize ETP investment decisions.

- Expand the technology selection process to include a broader array of stakeholder interests and perspectives, to increase the transparency and rigor with which the process is undertaken, and to ensure that technology selection priorities align with the ultimate goals of the ETP as specified by ETP staff and the CPUC.

- Create consistent project naming and numbering conventions, decision documentation, and feedback loops between the ETP and the EE programs to which technologies are recommended for transfer.

- Enhance data tracking systems and activities (e.g., assign unchanging master ID numbers to ETP projects, archive data in a standard format as it is collected) to improve ETP implementation and support ETP evaluation.

- Increase collaboration with the CPUC and other program stakeholders to establish standards for the design, execution, and documentation of technology assessments to promote consistently high-quality assessment projects, and thereby increase the value of the ETP.

- Continue dialogue with the CPUC to ensure a smooth transition to the 2010-2012 program cycle by reaching agreement on the indicators that will be used to assess program progress during the 2010-2012 evaluation cycle, the success criteria associated with these indicators, and the requisite routine data collection and documentation processes to be incorporated into program implementation.

2.6. Behavior Studies

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.

The key findings from these papers are:

- Climate change is the driving force for energy efficiency programs, including behavior change programs.
- An urgent and comprehensive response is needed to address climate change, including behavior change programs.
- Energy efficiency efforts need to foster innovative products, services, ideas and programs.
- Research and development efforts need to be based on experimental design and market segmentation.
- Behavior change strategies offer the potential for large-scale energy savings.
- Evaluation and attribution methods need to be revised to account for energy savings and non-energy benefits from behavior change strategies, using experimental design.
- Collaboration and communication among utility staff, policymakers, researchers, academics, and consultants needs to improve.
- The CPUC should ensure that behavioral issues are integrated in the implementation of future energy efficiency programs.

Summaries of these studies are provided in the remainder of this section.

Pursuing Energy-Efficient Behavior in a Regulatory Environment: Motivating Policymakers, Program Administrators, and Program Implementers

This white paper examines how policymakers, program administrators, and program implementers can be motivated to pursue behavioral change in a regulatory environment. For the purposes of this report, behavior change is defined rather broadly, encompassing both behaviors associated with the purchase and installation of energy-efficiency technologies as well as behaviors, decisions, and actions that might be thought of as more independent of technology. The latter include energy use habits, lifestyle choices, and consumption patterns. The insights and lessons discussed in this paper are drawn from a wide variety of sources including interviews with representatives from the energy and utility communities, as well as program documentation for energy-related programs and projects. The paper also draws from information on non-energy related programs that operate within a similar environment, and publications that explore the effective strategies of high-performance government organizations. The three primary goals of this report include: (1) identifying common perceptions of behavior change strategies; (2) identifying contexts in which program administrators, implementers and others have been or are likely to be motivated to pursue

behavior change as a means of reducing energy consumption; and (3) specifying effective policy options to further motivate policymakers, program administrators, and program implementers to pursue behavior change as a means of enhancing energy and carbon savings.

The Climate Imperative and Innovative Behavior: Encouraging Greater Advances in the Production of Energy-Efficient Technologies and Services

This white paper examines why a larger array of innovative institutions, behaviors, technologies, and services is needed – specifically in the context of what we call "the climate imperative." The author explores possible mechanisms that can encourage the more robust development of innovative programs and policies within the State of California, with special attention to the activities of the California Public Utilities Commission. The potential for future innovation is described in the context of California's impressive past technological and institutional achievements, especially as they impact energy efficiency improvements and energy policy more broadly. Notwithstanding its past achievements, the author contends that if the Golden State is to meet the climate imperative head-on it will need to promote significantly greater levels of innovation in the development of new ideas, new services, and new technologies – and to do so at a scale that has not been previously imagined or managed. This will demand innovation in all of the four stages of the technology development pipeline.

Using Experiments to Foster Innovation and Improve the Effectiveness of Energy Efficiency Programs

Experimentation is a critical requirement in the process of innovation. It is the mechanism that innovators use to identify what works and what does not work during the process of product development and marketing. Historically, there is very little evidence of the use of experimentation to test alternative energy efficiency program design features offered by utilities in California or elsewhere. Instead, programs tend to emerge full−blown from concept testing to implementation – without significant prototype development and testing. This paper argues that realistic small-scale experimental versions of key program components (i.e., messages, delivery channels, social network effects, etc.) should be completed prior to any full-scale pilot testing. To stimulate interest and thought about how experimentation can be used to improve program performance, this paper describes a number of experimental techniques that can be applied to the study of the impacts of behavioral factors on consumer decision−making. It provides examples of important research questions that can be answered using experimental techniques. It further discusses several institutional problems that are significant barriers to innovation and the use of experimentation in energy efficiency program development.

Behavioral Assumptions in Energy Efficiency Potential Studies

This white paper considers the behavioral assumptions in energy efficiency potential studies, and options for modifying and supplementing these assumptions, using recent California energy efficiency potential studies as the main example. Besides fulfilling planning and administrative roles as intended, energy efficiency potential studies present a statement on what energy efficiency programs can and should do, and even a template for thinking on the diffusion of energy efficiency and the future energy use of society. Such broader interpretations, of interest outside the utility planning community, transcend the original intended scope of the studies. An analysis of the behavioral assumptions of energy efficiency potential studies properly considers both what is expressed in energy efficiency potential studies on their own terms, as well as what these studies –

and device-centered views of energy efficiency in general – miss. This paper addresses both the narrower and broader views of bottom-up energy efficiency potential studies.

Behavioral Assumptions Underlying California Residential Sector Energy Efficiency Programs

This white paper explores the ways in which residential consumers are addressed by California utility-managed energy efficiency programs, and to offer suggestions for improvements in support of the state's ambitious greenhouse gas reduction goals. This paper first reviews the assumptions that underlie the state's residential energy efficiency policies and programs, and then examines the portfolio of residential energy efficiency programs currently operated by the regulated utilities. The paper then considers a series of social science reviews of energy efficiency programs and paradigms and then considers some alternative perspectives on energy user behavior and choice. The concluding section of the white paper discusses evolving program perspectives and strategies and identifies a number of key research questions, such as: (1) research on the fundamentals of consumption and choice, (2) research to improve communications and influence, and (3) research to support joint private/public action.

Behavioral Assumptions Underlying Energy Efficiency Programs for Businesses

This white paper describes the behavioral assumptions underlying utility sponsored energy efficiency programs offered to businesses in California. The author describes how assumptions about business decision making (that are built into the design of these programs) can affect the ability of these programs to foster increased investment in energy efficient technology. Challenges to the program design and evaluation community are identified, and recommendations are made to address these challenges.

Market segmentation and energy efficiency program design

This white paper describes the existing state of market segmentation among California's electric utilities, with an emphasis on the investor-owned utilities (IOUs). The paper covers how segmentation is applied in various other economic sectors, in part to provide a framework to identify potential practices that could be effectively adopted in the utility industry. Segmentation is an important marketing tool. If used effectively, it can result in the advancement and uptake of products and services that more closely match household and business needs, inform marketing campaigns so that they can more successfully motivate the various populations to take action, and lead to faster and more widespread adoption of new technologies. In depth application of market segmentation has only recently emerged within the utility sector as a way to implement demand-side management programs among residential and non-residential customers. Greater use of this marketing approach could help the state achieve its ambitious energy efficiency and conservation goals.

Process Evaluation Insights on Program Implementation

This white paper provides a resource to energy efficiency program implementers and designers by extracting lessons learned from process and market evaluation experience over the past 30-plus years (1975 to 2008) in which energy efficiency programs have operated in the United States. There are many lessons that have been learned over the course of over 30 years in implementing energy efficiency programs; key among them is that process evaluations are useful. Most of the interviewed contacts with more than 15 years of experience described a process among program administrators

of slow and steady recognition that evaluation is important. Process evaluation should be included from the beginning of program implementation (not as an afterthought), since process evaluation functions best as a management tool, not as a grading system. This paper, therefore, seeks to focus on two things: one, the lessons learned about program implementation and, two, a discussion of evaluation methods. The discussion of process and market evaluation methods is to help implementers gain a greater understanding of what is and is not a process evaluation, and to help evaluation practitioners assess how to handle challenges in evaluation practice.

Lessons Learned and Next Steps in Energy Efficiency Measurement and Attribution: Energy Savings, Net to Gross, Non-Energy Benefits, and Persistence of Energy Efficiency Behavior

This white paper examines four topics addressing evaluation, measurement, and attribution of direct and indirect effects to energy efficiency and behavioral programs:

- Estimates of program savings (gross);
- Net savings derivation through free ridership / net to gross analyses;
- Indirect non-energy benefits / impacts (e.g., comfort, convenience, emissions, jobs); and
- Persistence of savings.

Evaluation and attribution methods have reached a point that they must evolve in order to provide credible results for the next generation of programs. New program generations have complicated evaluation. Education, outreach, training, and market-based approaches make it harder to count "widgets" and assign savings for energy efficiency programs. New and multiple actors providing programs and outreach within utility territories increases the influence "chatter" and make it harder to isolate the impacts associated with one agency's program, or even the influence of one vs. another program from one utility or entity. These important evaluation complexities have become harder to ignore. Some have argued that traditional evaluation approaches are failing and not worth conducting. Others have proposed modifications and patches. It may be the case that varying and evolving programs may not be suited to "one size fits all evaluation protocols" and need tailored evaluations, but, to paraphrase, not measuring is not the best answer. The best programs will not be identified – or valued and taken seriously by system planners and regulators – unless they are measured and verified.

A review of the state of evaluation in these areas – gross and attributable net savings, and non-energy benefits – suggests some lessons are old lessons (up-front evaluation design and random assignment may seem difficult, but there is no reliable "after the fact" substitute). Some are new possibilities (for example, reflecting market share through price decomposition, revisions to the regulatory tests to incorporate NEBs). Some concessions to chatter and overlaps may be needed (portfolio-level decision-making or scenarios may be an appropriate evolution). There needs to be more up-front market assessment and baseline attention (saturation studies, perhaps augmented with behavioral aspects) to support evaluation of effects at least at the portfolio level. In some cases, deemed estimates associated with template program types may be appropriate if they are updated based on periodic measurement. Most importantly, evaluations need to continue and to loop back to program design to assure that the public dollars are being well-spent and "wrong" program decisions are avoided.

2.7. IOU Process Evaluations

Although not within the scope of this report, the IOUs also conducted 27 process evaluations during the 2006-2008 program cycle. These process evaluations were intended to provide 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 will be incorporated into the programs as on-going improvements and will influence planning of future programs. A list of these evaluations and studies, including links to the original reports, is presented below.

Table 16. IOU Process Evaluations in 2006-2008

IOU	Evaluation Type	Report	Link
SCE	Process	2006-2008 Energy Centers (CTAC/AGTAC) Process Evaluation	http://calmac.org/publications/SCE_EC_06-08__EValReport.pdf
SCE	Process	2006-2008 Retro-Commissioning Program Process Evaluation	http://calmac.org/publications/2006-2008_SCE_RCx_Program_FINAL_061109.pdf
SCE	Process	2006-08 Process Evaluation for SCE IDEEA Programs	http://calmac.org/publications/PE_2006-08_IDEEA__InDEE_Programs_V1_RIA_100809.pdf http://calmac.org/publications/PE_2006-08_IDEEA__InDEE_Programs_V2_RIA_100809.pdf http://calmac.org/publications/PE_2006-08_IDEEA__InDEE_Programs_V3_Cadmus_100809.pdf http://calmac.org/publications/PE_2006-08_IDEEA__InDEE_Programs_V4_SummitBlue_100809.pdf http://calmac.org/publications/PE_2006-08_IDEEA__InDEE_Programs_V5_Cadmus_100809.pdf
SCE	Process	Local Government/Institutional Partnerships Process Evaluation	http://calmac.org/publications/06-08_SCE_Local_Govt_Inst_Partnerships_Process_Evaluation_Report.pdf
SCE	Process	Home Energy Efficiency Survey Program Process Evaluation	http://calmac.org/publications/SCE_HEES_Final_Report_080409_calmac_edit.pdf
SCE	Process	Green Schools Process Evaluation	http://calmac.org/publications/SCE_HEES_Final_Report_080409_calmac_edit.pdf
SCE	Process	Green Campus Process Evaluation	http://calmac.org/publications/PE_EARTH_Education_&_Training_Program_FINAL_082109.pdf
SCE	Process	Living Wise Process Evaluation	N/A
SCE	Process	Process Evaluation CPACS Program 2007-08	http://calmac.org/publications/CPACS_2007-2008_Review_Final.pdf
SCE	PE/MA	Codes & Standards PE/MA	http://calmac.org/publications/C&S_Combined_Study_Report_041509.pdf
SCE	PE/MA	Sustainable Communities PE/MA	http://calmac.org/publications/Final_Sustainable_Communities_Process_Study_Report_-_CALMAC.pdf
SCE	PE/MA	California New Homes PE/MA	http://calmac.org/publications/SCE_CANHP_Final_Report_042009.pdf
SCE	PE/MA	Savings by Design PE/MA	http://calmac.org/publications/Savings_By_Design_Process_Study_Report_051909.pdf
SCE	PE/MA	Palm Desert Partnership PE/MA	http://calmac.org/publications/PDP_0708_Process_Evaluation_Final.pdf
SCE	Market	2006 Residential Market Share Tracking	http://calmac.org/publications/Appliances2006_Report_Final.pdf

IOU	Evaluation Type	Report	Link
SEMPRA	Process	2006-8 SDG&E Residential Process Evaluation	http://www.calmac.org/publications/SDG&E_Res_Report_Final,_021508.pdf
SEMPRA	Process	2006-8 SDG&E NON-Residential Process Evaluation	http://www.calmac.org/publications/SDGE_FINAL_Report__Volume_I_of_III.pdf; http://www.calmac.org/publications/SDGE_FINAL_Report_-_Volume_II_of_III.pdf; http://www.calmac.org/publications/SDGE_FINAL_Report_-_Volume_III_of_III.pdf
SEMPRA	Process	2006-2008 SDG&E Partnership Program Process Evaluation	http://www.calmac.org/publications/SDGE_LGP_Process_Evaluation_Report_FINAL_1-5-09.pdf
SEMPRA	Process	SDG&E New Construction Process Evaluation	http://www.calmac.org/publications/SDG&E_New_Construction_Process_Evaluation_Study_ReportV2.pdf
SEMPRA	Process	2006-8 SoCalGas Residential Process Evaluation	http://www.calmac.org/publications/SCG_Res_Report_Final_021508.pdf
SEMPRA	Process	2006-8 SoCalGas NON- Residential Process Evaluation	http://calmac.org/publications/SCG_Final_Report_Vol_I_of_III.pdf http://www.calmac.org/publications/SCG_Final_Report_Vol_II_of_III.pdf http://www.calmac.org/publications/SCG_Final_Report_Vol_III_of_III.pdf
SEMPRA	Process	2006-8 SoCalGas FOOD SERVICE Process Evaluation	http://www.calmac.org/publications/KEMA_FSEC_final_report_2008-11-14.pdf
SEMPRA	Process	2006-8 SoCalGas STEAM TRAP & MISC. Process Evaluation	http://www.calmac.org/publications/Steam_Trap_Billing_Analysis_Report.pdf
SEMPRA	Process	2006-2008 SoCalGas Partnership Program Process Evaluation	http://www.calmac.org/publications/SCG_LGP_Process_Eval_Final_Report_1-2-09.pdf
SEMPRA	Process	SoCalGas New Construction Process Evaluation	http://www.calmac.org/publications/SoCalGas_New_Construction_Process_Evaluation_Study_ReportV2.pdf
SEMPRA	M&V	2006-8 SDG&E Small Business Light Logger Study	http://www.calmac.org/publications/2006_SuperSaver_Hours_Report_2006-09_FINAL.pdf
SEMPRA	M&V	2006-8 SDG&E Express Efficiency Light Logger Study	http://www.calmac.org/publications/SDGE_ExpressEfficiencyFinal_ReportCalmac_021507.pdf
SEMPRA	M&V	2006-8 SDG&E MFR Boiler Control Study	http://www.calmac.org/publications/MFR_Boiler_Controls_Final_Report_April_22_08.pdf
SEMPRA	M&V	2006-8 SoCalGas MFR Boiler Control Study	http://www.calmac.org/publications/MFR_Boiler_Controls_Final_Report_April_22_08.pdf
PGE	Process	Process Evaluation and Strategic Assessment of PG&E's Food Service Technology Center	http://calmac.org/publications/PGE_FSTC_Eval__Report_-_Final_Feb_14_2008.pdf
PGE	Process	Process Evaluation of the Statewide Partnership Programs and Bakersfield/Kern County Partnership	http://calmac.org/publications/PGE_Summary_Report_Process_Evaluation_2006-2008_Statewide_Partnership_Programs.pdf
PGE	Process	Process Evaluation, Mass Market, PG&E Upstream Lighting CFL Program	http://calmac.org/publications/PGE_Mass_Market_Report_FINAL.pdf
PGE	Process	Process Evaluation Study of the PY2006-2008 Medical Energy Efficiency Programs	http://calmac.org/publications/PE_PG&E_Medical_Efficiency_Program_031010.pdf
PGE	Market	Market Baseline Study of the Business and Consumer Electronics Program	http://calmac.org/publications/Final_BCE_Report_123109_Volume_1.pdf
PGE	Market	Target Market Customer Survey	n/a
PGE	Market	Codes and Standards Market Adoption Estimation Methods	n/a
PGE	M&V	Measurement and Evaluation Study of the PY2006-2008 Schools and Colleges	http://calmac.org/publications/PGE_Schools_Final__Rpt_011609_final_revision.pdf

IOU	Evaluation Type	Report	Link
		Program	
PGE	M&V	Measurement and Evaluation Study of the PY2006-2008 Ag and Food Processing Program	http://calmac.org/publications/PG&E_AG_and_FP_Report_20090727.pdf
PGE	M&V	Measurement and Evaluation Study of the PY2006-2008 High Tech Program	http://calmac.org/publications/HighTechProcessEval_Rpt_FINAL_2009May20.pdf
PGE	M&V	Measurement and Evaluation Study of the PY2006-2008 Mass Market Segment	http://calmac.org/publications/PGE_Mass_Market_Report_FINAL.pdf

3. EVALUATION REPORTING TOOLS (ERT) METHODOLOGY

The 2006-2008 evaluations required a priority focus on measure specific estimates of savings and the ability to update key parameters in the utility reported savings for these measures as filed with the Commission. Consequently a suite of tools and processes was developed to:

- Standardize the tracking data submitted from each of the IOUs;
- Match the tracking data to the savings and costs reported to the Commission;
- Update the utility reported savings parameters from the detailed program tracking with evaluated results; and
- Produce aggregate impacts by utility, program or technology.

In addition, the ability to aggregate evaluation results in a centralized system allowed for measure specific evaluation designs (HIM studies) to cut across programs to increase sample size and for the results to be pulled together at the program level in the centralized database. The resultant data set has the multiple benefits of providing estimates of savings, benefits, and costs for each IOU or the four IOUs combined, for specific programs, for technologies, and includes all the necessary data required for the risk reward incentive mechanism. The details about how these tools are designed and the core components are described in this section.

The Evaluation Reporting Tools (ERT) is the suite of tools and processes that work in concert to produce the final evaluated results of the 2006-2008 energy efficiency portfolio. The ERT was developed through the collaborative work of several technical advisors, professional programmers, and evaluation consultants (the ERT Team). The three core components of the ERT are described in this section: 1) The E3 Calculator engine, 2) The Standardized Program Tracking Database, and 3) The ERT Application. More detailed information can be found in Appendices H-N. These components are represented in Figure 22 below:

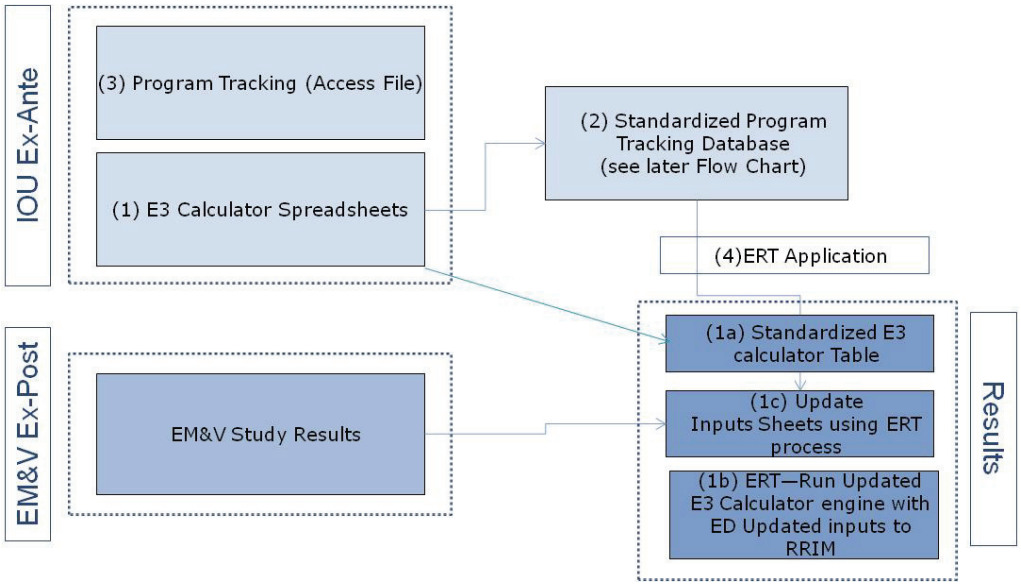


Figure 22. Evaluation Reporting Tools Diagram

3.1. E3 Calculators

The E3 calculator is the official CPUC EE program cost-effectiveness tool used to calculate utility energy savings and total net benefits for energy efficiency programs and portfolio.. Energy Division requires that E3 calculators be submitted quarterly by the IOUs, along with the corresponding IOU program tracking data. The savings and costs reported in the E3 calculators aggregate approximately 4.5 million IOU program tracking records down to approximately 21,000 E3 calculator lines. The E3 calculators are publicly available through the EEGA website.[52] The E3 calculator determines cost effectiveness (using the Total Resource Cost test), avoided costs and benefits, and additional data that is not present in IOU program tracking data such as ex-ante load shapes, ex-ante effective useful life (EUL), and ex-ante net-to-gross (NTGR). Generally, IOUs submit one E3 calculator (MS Excel workbook) per program or program element, totaling about 247 E3 calculator spreadsheets across the entire portfolio. This is reflected in Figure 22, box 1 above.

3.1.1. E3 Calculator Spreadsheets – Standardized

Out of the 247 submitted E3 calculator spreadsheets, the data from 170 E3 calculator spreadsheets for programs that reported energy savings were consolidated into one table in the ERT application totaling 20,686 records. (See Figure 22, box 1a.)

To enable a systematic, centralized mapping of IOU program tracking data to E3 claim lines, the ERT team developed a tool to combine all E3 calculators in a single, standardized table. At a high level, the standardized E3 calculator table combines the 177 MS Excel E3 calculator files into a single data

[52] The IOUs report energy savings on a monthly, quarterly and annual basis to the EEGA website, http://eega2006.cpuc.ca.gov/ .

table with well-defined, consistent fields. The standardized E3 calculator table maintains traceability by storing the data source of record and by assigning a primary key[53]. Previous versions of this table were used in the first and second verification reports.[54] This table is found in the *ERT application .mdb* file.

3.1.2. New E3 Calculator Engine

Several adjustments to the E3 calculator spreadsheets were required to accommodate the evaluation updates to the program tracking data. The results from the E3 calculator spreadsheets are created by the E3 calculator engine. Each utility has a unique E3 calculator engine. There are also different versions of the E3 calculator engine, and this section describes versions and changes made since the second verification report. The E3 calculator engine Figure 22, box 1b) used for this report is version 4f2 (available for download at http://www.ethree.com/cpuc_cee_tools.html).

Version 4f2 2/19/10

Applies to

- SoCal Tool NTG 4f2 (800).xls
- SDGE Tool NTG 4f2 (800).xls
- SCE Tool NTG 4f2 (1000).xls

Based on

- SoCal Tool NTG 4f (800).xls
- SDGE Tool NTG 4f (800).xls
- SCE Tool NTG 4f (1000).xls

Summary of Changes

1. Error trap for EULs less than 0.3. Prior versions assigned no benefits.
2. Fix problem for RIM calculations where EUL less than 1.0.
3. Relax input restrictions on measure and program that were used to match EULs and NTGs.
4. Revise Visual Basic WriteResults macro to go out through column T for Output and Export tabs.
5. Shift gas rates in Rates tab down one column to match PGE calculator (used as master for equation changes).
6. Change Col I of Gas Calcs to accommodate gas rate range change.
7. Fix gas NO_X calculation reference for Cols IN, IO, to use GasCalcs Col J instead of Col I. (SDGE only).

[53] A primary key is a way to uniquely identify each and every record in a database table.

[54] The First and Second Energy Efficiency Verification Reports are available at http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/081117_Verification+Report.htm .

Version 4f2 2/19/10 (PGE)

Applies to
- PGE Tool NTG 4f2 (800).xls

Based on
- PGE Tool NTG 4f (800).xls

Summary of Changes

1. Relax data validation on measure type (used for EULs)
2. Revise Visual Basic WriteResults macro to go out through column T for Export tab

Version 4f 2/1/10

Applies to
- SoCal Tool NTG 4f (800).xls
- SDGE Tool NTG 4f (800).xls

Based on
- SoCalTool NTG 4e2 (800).xls
- SDGE Tool NTG 4e2 (800).xls

Summary of Changes

1. Revise NTG costs so it uses kWh NTG if therms are zero, Th NTG if kWh is zero, or NTG from larger of kWh savings * 0.03412 or therms

Version 4e2 1/22/10

Applies to
- SDGE Tool NTG 4e2 (800).xls
- SoCal Tool NTG 4e2 (800)

Based on
- SDGE Tool NTG 4e (800).xls
- SoCal Tool NTG 4e (800).xls

Summary of changes

1. Extend gas savings past 2024. This was a version 4c correction that was missed is the creation of the 4e versions
2. Remove sample inputs

Version 4e 12/19/09

Applies to
- PGE Tool NTG 4e2
- SDGE Tool NTG 4e (800)
- SCE Tool NTG 4e2 (800)
- SoCal Tool NTG 4e (800)

Based on
- PGE Tool NTG 4d
- SDGE Tool NTG 4d (800)
- SCE Tool NTG 4d (800)
- SoCal Tool NTG 4d (800)

Summary of Changes

1. Change to allow for multiple NTG ratios
2. Version 4e not released
3. Added three input rows for separate NTG ratios for kW, Therms, and Costs

4. If the user leaves the cell blank, the spreadsheet will use the kWh NTG ratio as a default.

5. Removed CEC kW metrics because that is a kW metric based on kWh. Given the differing NTG ratios, this metric is no longer applicable.

6. Expand the "Other" category for the CPUC End Use Category output table to include all measures that do not fall in a specified category. Label changed to "Other and unspecified."

7. Correct User Entered kW in Climate Zone table.

Version 4c ***11/23/09***

Applies to

- SDGE Tool 4c.xls
- SDGE Tool 4c (800).xls

Based on

- SDGE Tool 4b.xls
- SDGE Tool 4b (800).xls

Summary of changes

1. Extended gas benefits from 2024 through 2030 to allow calculation of benefits for gas measures past 2024

3.2. Standardized Program Tracking Database (SPTdb)

Tracking data submitted by each of the IOUs is not in a consistent format. A standardized format for the data was developed as well as a method to map the program tracking data to the E3 calculators. This dataset was developed in collaboration with the IOUs to enable analysis across the IOUs and the ability to map results to the E3 filed savings.

The Standardized Program Tracking Database (SPTdb) is an MS Access^{tm} database designed by Energy Division and its consultants to bring all IOU program tracking data together into a single, standardized table Figure 22, box 2). There is an SPTdb .mdb file for each utility (due to Access' 2GB size limit, PGE's data is broken up into two .mdb files). This section goes over the utility tracking data and the creation of the SPTdb. For detailed information on how the SPTdb was created please refer to the SPTdb Documentation found in Appendix I.

3.2.1. Utility Tracking Data

IOU energy efficiency (EE) program tracking data systems track IOU energy efficiency projects. These systems are primarily fed by energy efficiency program implementer project/measure-level data, which includes (but is not limited to) the following types of data:

- Site information (i.e., address, building type, climate zone)
- Incentive information (i.e., rebate issue amounts, incentive types, and dates)

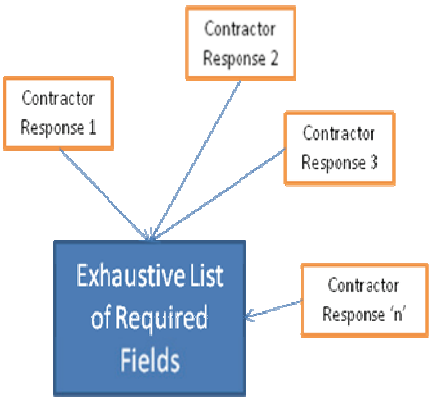
- EE measure information (i.e., EE measure name/type, baseline, deemed savings)

The IOUs submitted program tracking data (Figure 22, box 3) to Energy Division quarterly throughout 2006-2008, along with corresponding E3 calculators (discussed in the previous section). Generally, the program tracking data submitted to Energy Division is the product of a query of the IOUs' internal tracking systems. The output of this query is, generally, a single flat table (.mdb) that summarizes the cumulative IOU program tracking data at the time of the release; the exception to this rule is SCE, whose delivery consists of at least one .mdb file per program (this is addressed later in this document). Therefore, the fields given in the tracking data submitted to Energy Division are subsets of the total fields that exist in the IOU internal tracking database systems. Additionally, when the data is being translated from the IOU internal tracking databases to the IOU program tracking data, the data can receive different levels of aggregation/disaggregation, which can result in the "lumping" of different measures into a single line item of tracking data.

3.2.2. SPTdb Data Structure

To determine the necessary fields to be included in the SPTdb, the Energy Division polled all evaluation study team leads to ascertain which fields from all IOU datasets were used as part of their respective evaluation studies. This was a highly iterative and collaborative process between Energy Division, the IOUs, and all contract groups.

Figure 23. Contractor specification of necessary SPTdb fields



The process produced an exhaustive list of unique fields required by the contract groups. The table below shows the general structure of this table.

Table 17. SPTdb Data Field Request Sample

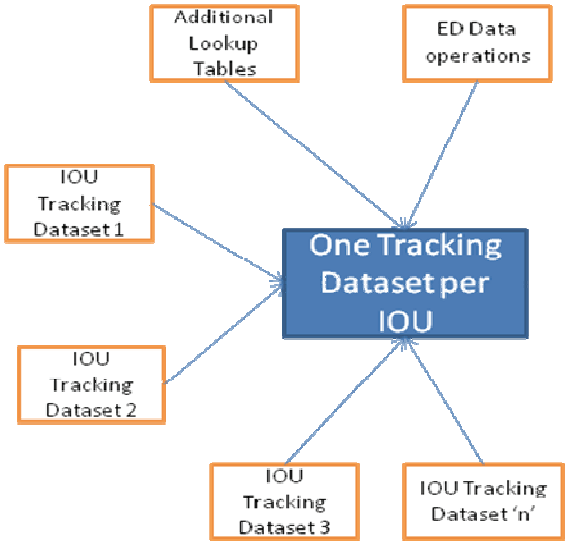
IOU	ProgramID	IOUPrgTrkDBName	IOUPrgTrkTableName	IOUPrgTrkUniqueFieldName
PGE	ALL	PGE_FROZEN_030209_2008Q.MDB	PGE_FROZEN_030209_2008Q	ACCEPT_DATE
PGE	ALL	PGE_FROZEN_030209_2007Q.MDB	PGE_FROZEN_030209_2007Q	ACCEPT_DATE

The resulting exhaustive list of unique fields was further refined, data types were specified, and the result of this process was the SPTdb Data Dictionary, whose specifics are discussed in the sections below. This data dictionary served as the source for the mapping of fields from IOU program tracking data to the SPTdb structure.

3.2.3. Consolidating IOU Data into a Single Dataset per IOU

All related IOU program tracking datasets, lookup tables, and various data request responses were consolidated into a single program tracking dataset per IOU. Energy Division, in collaboration with the IOUs, performed additional logic on the IOU-specific datasets to specify the "official" claimed data from the IOUs. This was necessary, as the IOU program tracking data did not always report values that matched the official E3 claim.

Figure 24. Process of creating a single dataset per IOU



3.2.4. E3 and Program Tracking Data Matching

E3 calculators are intended to simply roll tracking data up into consolidated lines for reporting. Therefore, ideally, for a given program or program element, the sum of savings and incentives being reported in the tracking data corresponding to a certain E3 calculator would match, exactly, the sum of the savings and incentives being reported in the E3 calculator. Furthermore, the sum of the savings and incentives of the line items of tracking data related to a single E3 calculator line item should exactly match the savings and incentives reported for that line item in the E3 calculator.

In many cases, the E3's did, match the related tracking data being reported. However, this frequently was not the case, and Energy Division, the ERT team, and the IOUs collaborated to determine what actions were necessary to ensure the correct numbers were being reported in the SPTdb.

3.3.5. Mapping IOU Program Tracking Data to SPTdb

As stated in the background, IOU program tracking datasets significantly vary across IOUs and even within IOUs. However, in general, the same process was used to address mapping IOU data to the SPTdb.

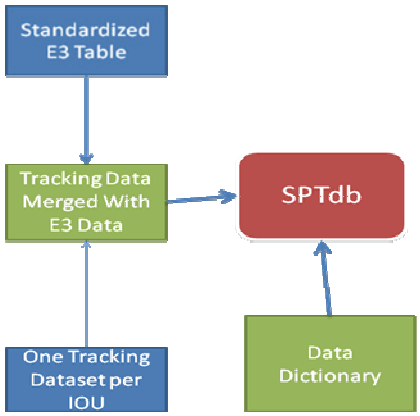
Merging tracking data with the standardized E3 table

The standardized E3 table was merged with each IOU-specific single tracking dataset via various algorithms developed by Energy Division, its contractors, or the IOUs. The IOU-specific E3 matching processes are addressed in the IOU data handling sections below. This merge, specifically, assigns an EDE3ClaimID foreign key to every line item of IOU program tracking data. The EDE3ClaimID is the primary key of the IOU_E3_Claim table. The merge shows how each line of program tracking data is rolled up to the line items in the E3 calculators.

Mapping IOU tracking data to the SPTdb data dictionary

Using logic provided by Energy Division, evaluation teams, and IOUs, IOU program tracking data fields were mapped to the standardized SPTdb fields via the data dictionary. This was a highly iterative and collaborative process that took significant time and refinement. The culmination of this process is illustrated in the diagram below.

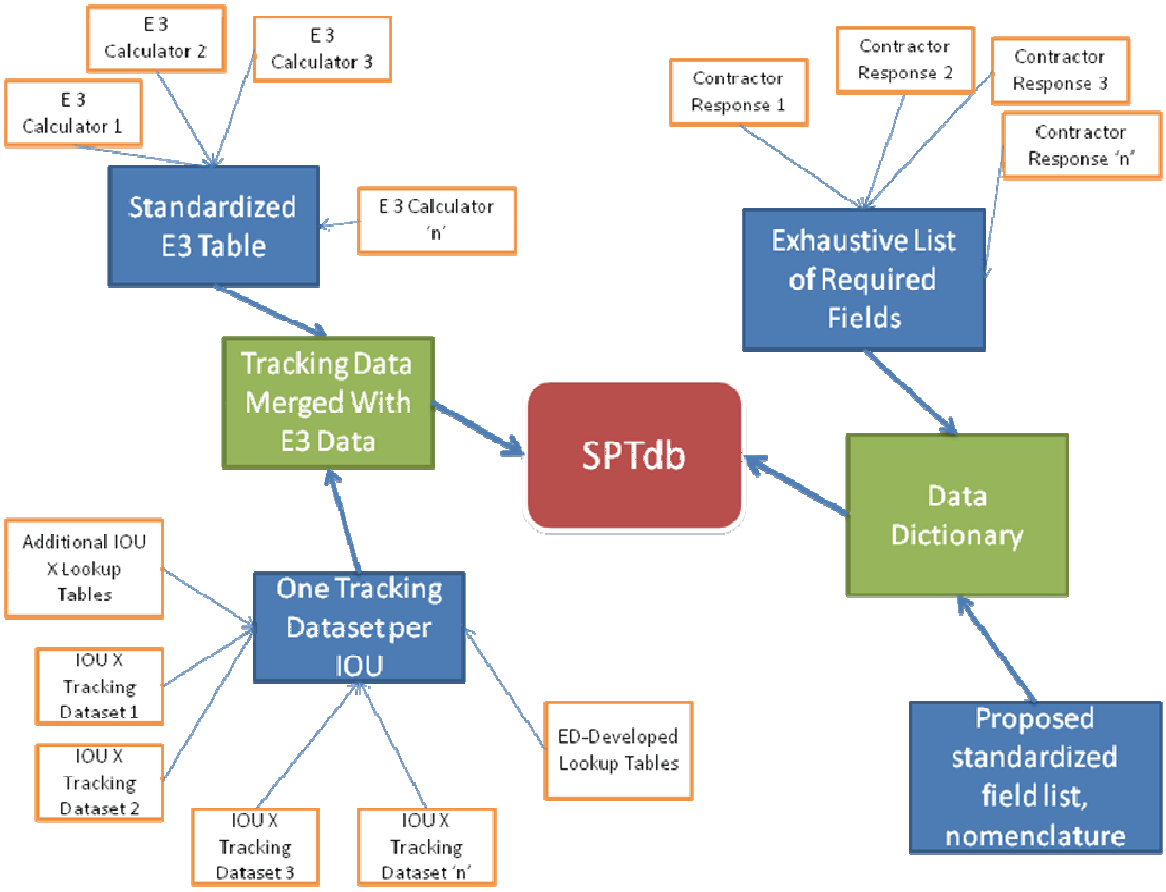
Figure 25. Process of mapping tracking data to the SPTdb.



3.2.6. Overall SPT db Process Diagram

This diagram shows the overarching SPTdb creation process as discussed above. Specifics of this process are illustrated below in Figure 23.

Figure 26. Overarching SPTdb creation process.

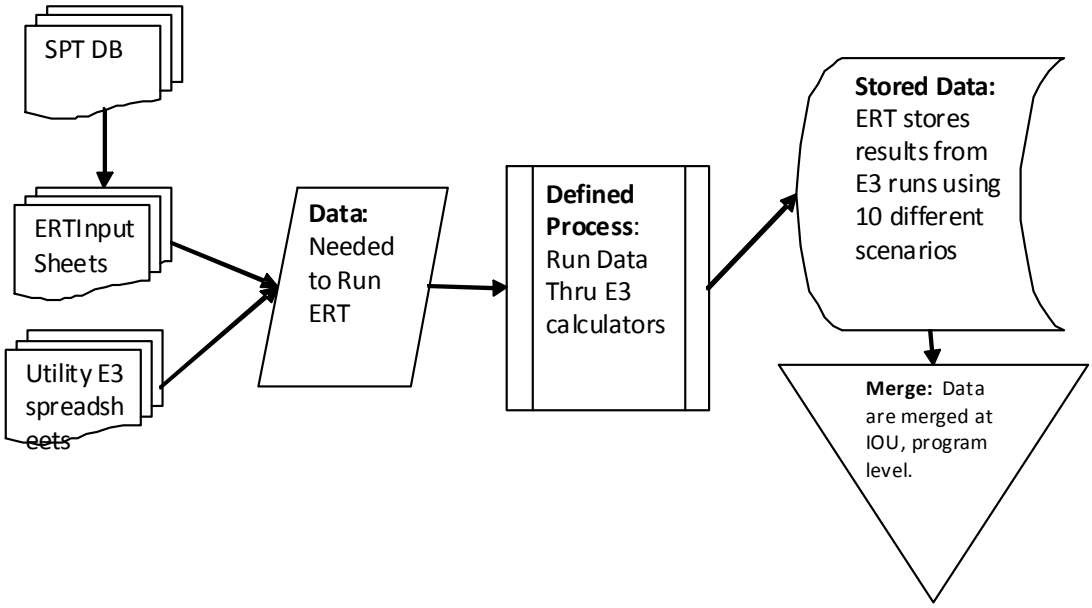


3.3. ERT Application

A relational database was developed to enable the systematic update of the utility reported savings parameters from the detailed program tracking database with evaluated results from measure specific or program evaluation results. This software tool allowed Energy Division to produce aggregate impacts by utility, program or technology.

The ERT Application Figure 22, box 4) is an MS Access[tm] database that is designed to accept measure level evaluated results, process those results through the appropriate E3 engine, and aggregate the processed results under ten pre-defined scenarios.

Figure 27. ERT Application



3.3.1. ERT Input Sheet

The key source of evaluation and reported data is the ERT Input Sheet Figure 22, box 1c). The ERT Input Sheet contains data fields provided in a specific format, as defined in the data specification file, "ERTE3Input 20100115.xls," found in Appendix C. The data fields are populated from a combination of sources including the Standardized Program Tracking Database, as well as the evaluation datasets. Each of the impact evaluation teams populated an ERT Input Sheet with data from each program that was included in the study designs for their respective evaluations.

Each contract group was responsible for submitting an input sheet for a certain number of programs. Typically these were the programs that they evaluated directly, and in some cases they were programs for which they had a high concentration of HIMs that they had evaluated.

In total, the ERT application requires 75 data fields in order to calculate energy savings and net benefits. Thirty-five of those fields within the ERT Input Sheet are provided by the evaluation teams, while the 40 remaining fields are either automatically computed through programming code in the ERT application or are pulled from the IOU_E3_Claim table already housed within the ERT application.

The following sections provide more detailed descriptions of the specific data groups.

3.3.1.1. Data from SPT db

Each impact evaluation populates the ERT Input Sheet with the following 19 fields from the SPT db:

FieldName	Description
EDE3ClaimID	Identifies the corresponding record in the IOU_E3_Claim table
EDFilledClimateZone	The ED climate zone
EDFilledDirectInstallLab	The incentive attributed to direct install labor
EDFilledDirectInstallMat	The incentive attributed to direct install of materials
EDFilledEndUserRebate	The incentive attributed to an end user rebate
EDFilledExAnteQuantity	The quantity
EDFilledGasSavProfile	The gas load shape has three possible values: Summer Only, Winter Only, or Annual
EDFilledGasSector	EDFilledGasSector has two possible values: Residential or Commercial.
EDFilledGrIncentivePaid	The gross incentive paid
EDFilledGrMeaCost	The gross measure cost from the E3 line apportioned by EDFilledExAnteQuantity
EDFilledIncentiveToOthers	The incentive attributed to incentives paid to others
EDFilledMeaElecEndUseShape	The electric load shape used
EDFilledPaidDate	The paid date
EDFilledTargetSector	The market, for example, 'Residential', 'Res_New_Construction', 'Industrial', 'Agriculture', etc…
EDFilledUESkW	The gross unit energy savings for kWh
EDFilledUESkWh	The gross unit energy savings for Therms
EDFilledUESTherms	The gross unit energy savings for kW
EDPrgID	Unique program identifier; EDIOU plus 4 digit number
EDPrgTrkClaimID	Primary key

These data fields have not been adjusted as a result of the evaluation study results; however, they were derived as a result of Energy Division's effort to populate these necessary fields in order the run the E3 engine at the program tracking level**.** These fields begin with "EDFilled_."

3.3.1.2. Data from Evaluation Reports (ED Update)

The ERT Input Sheet requires the impact evaluation teams to populate 16 fields with data from their respective evaluation studies. The values found in these fields for unit energy savings (UES) and net-to-gross (NTG) will match the results from the evaluation studies, except in a few instances, which are documented in the ERT Input Sheet documentation found in Appendix C.

FieldName	Description
EDDEERImpactID	DEER impact ID
EDIRate	Installation rate from evaluation studies
EDUESkW	Unit demand savings from evaluation studies
EDUESkWh	Unit electricity savings from evaluation studies
EDUESTherms	Unit natural gas savings from evaluation studies
EDUESkWi	Unit demand savings from evaluation studies with interactive effects factor applied
EDUESkWhi	Unit electricity savings from evaluation studies with interactive effects factor applied

FieldName	Description
EDUESThermsi	Unit natural gas savings from evaluation studies with interactive effects factor applied
EDNTGRkW	Net-To-Gross ratio from evaluation studies applied to demand savings
EDNTGRkWh	Net –To-Gross ratio from evaluation studies applied to electricity savings
EDNTGRTherms	Net-To-Gross ratio from evaluation studies applied to natural gas savings
EDEUL	Effective Useful Life updated from DEER2008
IRateType	Indicates if install rate came from an EMV study or was a pass thru (used utility value)
UESType	Indicates if Unit Energy Savings came from the contract group's EMV study, another contract group's EMV study, DEER, or pass thru (used utility value)
NTGRType	Indicates if Net-To-Gross ratio came from the contract group's EMV study, another contract group's EMV study, DEER, or pass thru (used utility value)
EULType	Indicates if Effective Useful Life came from DEER or pass thru (used utility value)

3.3.1.3. Data from utility E3 reports (E3 Claim)

In addition to the 19 fields from the SPTdb and the 16 fields from the impact evaluation studies, the ERT application pulls an additional 10 fields from the utility E3 calculator spreadsheet data stored in the table, "IOU_E3_Claim_Q42008." Impact evaluation teams did not need to populate these fields in their ERT Input Sheet; the ERT application automatically populates these fields by joining the IOU_E3_Claim_Q42008 table with the ERT Input Sheet .txt file by the EDClaimID field to create a query table called "Evaluation."

FieldName	Description
IOUE3MeaName	Measure name from the IOU spreadsheet
IOUE3DEERRunID	DEER RunID
IOUE3ClimateZone	Climate Zone used in the IOU E3 spreadsheet
IOUE3TargetSector	Target sector used in the IOU E3 spreadsheet
IOUE3MeaElecEndUseShape	Electric end use shape used in the IOU E3 spreadsheet
IOUE3GasSector	Gas sector used in the IOU E3 spreadsheet
IOUE3GasSavProfile	Gas savings profile used in the IOU E3 spreadsheet
IOUE3TOUACAdjustment	% eligible for Time-of-Use AC adjustment
IOUE3NTGR	NTGR used in the IOU E3 spreadsheet
IOUE3EUL	EUL used in the IOU E3 spreadsheet

3.3.1.4. Computed Data

Finally, there are 30 additional fields that are needed for the ERT application to work, but these fields are automatically calculated from data already in the 35 fields provided by the evaluation teams in the ERT Input Sheet. The formulas for each field are listed the table below.

FieldName	Equation/Derivation/Value List
IRateAdjIOUE3GrMeaCost	EDFilledGrMeaCost * (1/EDIRate)
IRateAdjEDEndUserRebate	EDFilledEndUserRebate * (1/EDIRate)
IRateAdjEDIncentiveToOthers	EDFilledIncentiveToOthers * (1/EDIRate)
IRateAdjEDDirectInstallLab	EDFilledDirectInstallLab * (1/EDIRate)
IRateAdjEDDirectInstallMat	EDFilledDirectInstallMat * (1/EDIRate)
IRateAdjEDFilledQuantity	EDFilledQuantity * EDIrate
EDFilledQuantity2006Qtr1	If (qtr(EDFilledPaidDate)=2006Qtr1, EDFilledExAnteQuantity,0)
EDFilledQuantity2006Qtr2	If (qtr(EDFilledPaidDate)=2006Qtr2, EDFilledExAnteQuantity,0)
EDFilledQuantity2006Qtr3	If (qtr(EDFilledPaidDate)=2006Qtr3, EDFilledExAnteQuantity,0)
EDFilledQuantity2006Qtr4	If (qtr(EDFilledPaidDate)=2006Qtr4, EDFilledExAnteQuantity,0)
EDFilledQuantity2007Qtr1	If (qtr(EDFilledPaidDate)=2007Qtr1, EDFilledExAnteQuantity,0)
EDFilledQuantity2007Qtr2	If (qtr(EDFilledPaidDate)=2007Qtr2, EDFilledExAnteQuantity,0)
EDFilledQuantity2007Qtr3	If (qtr(EDFilledPaidDate)=2007Qtr3, EDFilledExAnteQuantity,0)
EDFilledQuantity2007Qtr4	If (qtr(EDFilledPaidDate)=2007Qtr4, EDFilledExAnteQuantity,0)
EDFilledQuantity2008Qtr1	If (qtr(EDFilledPaidDate)=2008Qtr1, EDFilledExAnteQuantity,0)
EDFilledQuantity2008Qtr2	If (qtr(EDFilledPaidDate)=2008Qtr2, EDFilledExAnteQuantity,0)
EDFilledQuantity2008Qtr3	If (qtr(EDFilledPaidDate)=2008Qtr3, EDFilledExAnteQuantity,0)
EDFilledQuantity2008Qtr4	If (qtr(EDFilledPaidDate)=2008Qtr4, EDFilledExAnteQuantity,0)
EDQuantity2006Qtr1	If (qtr(EDFilledPaidDate)=2006Qtr1, IRateAdjEDFilledQuantity,0)
EDQuantity2006Qtr2	If (qtr(EDFilledPaidDate)=2006Qtr2, IRateAdjEDFilledQuantity,0)
EDQuantity2006Qtr3	If (qtr(EDFilledPaidDate)=2006Qtr3, IRateAdjEDFilledQuantity,0)
EDQuantity2006Qtr4	If (qtr(EDFilledPaidDate)=2006Qtr4, IRateAdjEDFilledQuantity,0)
EDQuantity2007Qtr1	If (qtr(EDFilledPaidDate)=2007Qtr1, IRateAdjEDFilledQuantity,0)
EDQuantity2007Qtr2	If (qtr(EDFilledPaidDate)=2007Qtr2, IRateAdjEDFilledQuantity,0)
EDQuantity2007Qtr3	If (qtr(EDFilledPaidDate)=2007Qtr3, IRateAdjEDFilledQuantity,0)
EDQuantity2007Qtr4	If (qtr(EDFilledPaidDate)=2007Qtr4, IRateAdjEDFilledQuantity,0)
EDQuantity2008Qtr1	If (qtr(EDFilledPaidDate)=2008Qtr1, IRateAdjEDFilledQuantity,0)
EDQuantity2008Qtr2	If (qtr(EDFilledPaidDate)=2008Qtr2, IRateAdjEDFilledQuantity,0)
EDQuantity2008Qtr3	If (qtr(EDFilledPaidDate)=2008Qtr3, IRateAdjEDFilledQuantity,0)
EDQuantity2008Qtr4	If (qtr(EDFilledPaidDate)=2008Qtr4, IRateAdjEDFilledQuantity,0)

3.3.2. Scenarios

The ERT application uses various combinations of the 75 fields to produce results under ten scenarios described in this section. The ERT Input Sheet data specification file, "ERTE3Input20100115.xls" found in Appendix J and shows which fields are needed for each scenario.

3.3.2.1. No Update

Under this scenario none of the evaluation study results are used to compute the final results. Measure cost and energy savings data come from the SPT db and the EUL and NTGR values come from the utility reported E3 values. This scenario is the utility reported savings.

3.3.2.2. All_I

This scenario applies the evaluated installation rate and NTGR and DEER updated EUL values as well as the evaluated UES values with interactive effects factors applied. This scenario is the evaluated savings.

3.3.2.3. All

This scenario applies the evaluated installation rate and NTGR and DEER Updated EUL values as well as the evaluated UES values without interactive effects factors applied. This scenario is the evaluated savings without interactive effects.

3.3.2.4. Gross_I

No NTGRs are applied. This scenario applies the evaluated installation rate and DEER Updated EUL values as well as the evaluated UES values with interactive effects factors applied. This scenario is the gross evaluated savings.

3.3.2.5. Gross

No NTGRs are applied. This scenario applies the evaluated installation rate and DEER Updated EUL values as well as the evaluated UES values without interactive effects factors applied. This scenario is the gross evaluated savings without interactive effects.

3.3.2.6. UES_I

This scenario shows what the results would be if only the evaluated UES values with interactive effects factors applied are used. All other values either come from the SPT db or the utility E3 values.

3.3.2.7. UES

This scenario shows what the results would be if only the evaluated UES values without interactive effects factors applied are used. All other values either come from the SPT db or the utility E3 values.

3.3.2.8. NTGR

This scenario shows what the results would be if only the evaluated NTGR values are used. All other values either come from the SPT db or the utility E3 values.

3.3.2.9. EUL

This scenario shows what the results would be if only the DEER Update EUL values are used. All other values either come from the SPT db or the utility E3 values.

3.3.2.10. EDFilled

This scenario shows what the results would be if only the EDFilled_ values are used. All other values either come from the SPT db or the utility E3 values. EDFilled_ values are those utility values from the SPT db that were derived as a result of Energy Division's effort to populate these necessary fields in order to the run the E3 engine at the program tracking level. This is not to be confused with evaluated results.

3.4. Policy Direction for Updating IOU Claims (Decision Framework[55])

Energy Division staff was directed to address eight specific parameters in the evaluation of the 2006-2008 portfolio savings, per the *ALJ Ruling Adopting Protocols for Processes and Review of Post 2005 Evaluation Measurement and Verification (EM&V) Activities,* Attachment 2 "Performance Basis Protocol For Verifying Performance Basis Parameters And Joint Staff's Reporting Schedule," issued on January 11, 2006 in R.01-08-028 ("1-11-06 ALJ Ruling"). Subsequent Commission direction in D. 07-09-043 allows ED staff to utilize the following options in estimating program and portfolio impacts for the 2006-2008 program cycle:

1. Extrapolate findings from comparable programs to determine net resource benefits for programs that do not receive full impact evaluation; or

2. Accept reported savings values for programs that do not receive impact evaluation; or

3. Extrapolate savings findings from impact evaluations for comparable programs for some net resource benefit parameters and accept reported values for others; or

4. Apply a discount factor to savings or costs from programs that do not receive impact evaluation based upon historic impact evaluation results for comparable programs.

D. 08-01-042 (Ordering Paragraph 3, as modified by D.08-12-059, Ordering Paragraph 10) requires the application of the DEER ex ante updates. Applicable excerpts from these decisions can be found at the end of this section. Energy Division staff's application of these Commission directives (presented in text boxes at the beginning of each section) to update the IOU savings claims with the best available data from the evaluations and other sources to develop the final savings estimates is explained in the remainder of this section.

Eight specific parameters were identified in the Performance Basis Protocol and basic direction for updating those parameters was provided in Attachment 2 of the ALJ Ruling. This basic direction and modifications to this direction (based on subsequent decisions) are presented in the following sections by specific parameter.

[55] This document was presented to parties in an ERT workshop on December 2, 2009. It has been updated to reflect actual implementation of the plan.

3.4.1. Measure Installations

> *Program Administrators are expected to report on the number of measure installations and associated program costs throughout the 3-year program cycle. Joint Staff plans to have its contractors verify this information on measure installations by performing quality control checks on the measure installation inputs to the data base and verifying actual installations in a sample of customer premises using contact information provided by utilities. We expect Joint Staff verification efforts to lag the measure installation by 1 to 12 months, depending upon the type of project.*
>
> *We expect that administrators will submit their reports to Energy Division or its EM&V contractors that include cumulative measure installations from the previous program year (2006, 2007, and 2008) on February 28th of each year.2 Joint Staff would plan to make its best effort to verify the installation counts by program and provide this interim estimate to each utility administrator on July 1st of each year and then publish the final estimate as part of its August report. Joint Staff would work with the administrators to resolve any misunderstandings or communication issues that might have led to differences in verified installations before developing an interim estimate of the performance basis for the portfolio in the August 1st report. (1-11-06 ALJ Ruling, Attachment 2, p.3.)*

A "verified installation" is an installed measure or technology that is the same as what was reported, is program eligible, and is operating as intended. A measure can also refer to a combination of upgrades made to a facility to improve its process efficiency or other system improvements. A "verification site" is a site that was selected for a minimal level of evaluation but may include multiple measures, and this term was used in the impact evaluation reports to describe the evaluation work. Evaluation contractors verified installations in accordance with the Evaluator Protocols (pg 56-57), which states:

> *"The objectives of measure installation verification are to confirm that the measures were actually installed, the installation meets reasonable quality standards, and the measures are operating correctly and have the potential to generate the predicted savings. Installation verification shall be conducted at all sites claiming energy or peak demand impacts where M&V is conducted."*

The 2006-2008 program cycle evaluations included field and phone verification of measure installations to verify 77% of kWh, 73% of kW, and 39% of therm energy savings in the portfolios. The results of many of these evaluation activities were presented in the two "Verification Reports" issued by ED staff. The reports provided by contractors include final installation rates results for the evaluated program and high impact measures (HIM) populations and discuss the reliability of the results. Installation rate adjustments were either applied for the full program cycle or for specific years if available. Measure installation methodologies for Upstream Lighting, Refrigerant Charge and Airflow (RCA) and Duct Test and Seal were explained in their respective evaluation reports, and the documentation for those programs is provided in Appendix C.

Adjustments to utility claims for measure installations that were not directly evaluated (i.e. were not part of a program or HIM evaluation study design) were considered for update based on the availability of reliable[56] evaluation results from comparable programs or measures targeted at

[56] **Reliable**: An evaluated result or value that has met statistical expectations based on the study design and professional evaluators can confidently defend, and have fully documented in their evaluation reports.

similar customers using similar delivery mechanisms that make these results applicable.[57] The definitions of reliable and applicable were developed by Energy Division and their technical advisors. The cases that were extrapolated from other evaluation results comprised less than 1 percent of any portfolio savings. In the case of updating IOU measure installation claims, ED staff and contractors considered:[58]

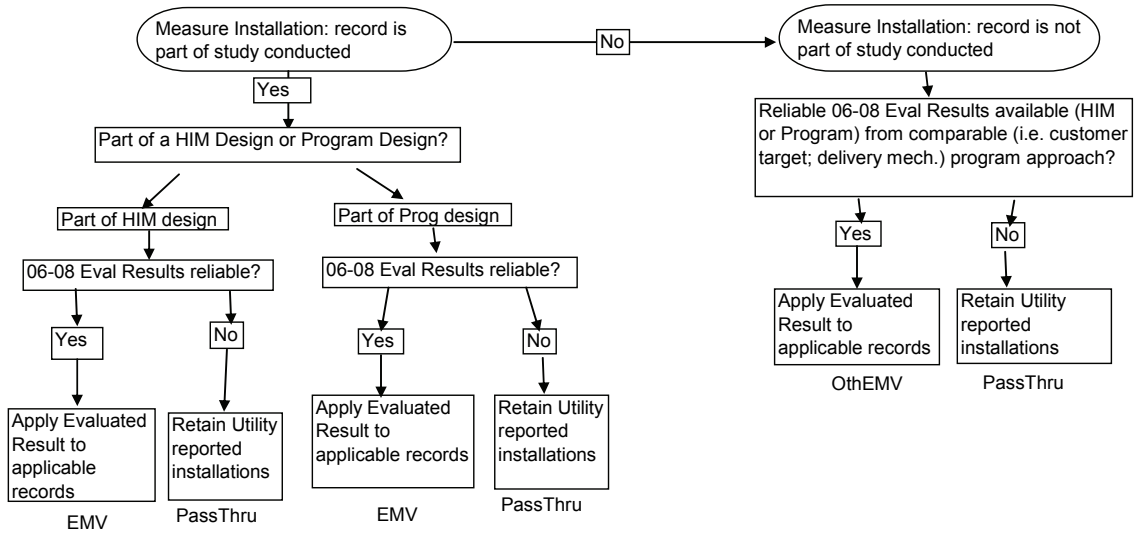
> Option 1.) Extrapolate findings from comparable programs to determine net resource benefits for programs that do not receive full impact evaluation; 1% of kWh kW, and therm reported savings received this treatment.
>
> Option 2.) Accept reported savings values for programs that do not receive impact evaluation. About 23% of kWh and 26% kW, and 61% of therm ex-ante savings claimed received this treatment.

Because measure installation is only one parameter, option 3 (i.e., 3. Extrapolate savings findings from impact evaluations for comparable programs for some net resource benefit parameters and accept reported values for others.) did not apply.

Given time constraints to extract results from prior studies and concerns about comparability with prior studies, Energy Division did not consider option 4 for measure installations (i.e., 4. Apply a discount factor to savings or costs from programs that do not receive impact evaluation based upon historic impact evaluation results for comparable programs.).

The direction for applying DEER ex-ante updates does not apply to measure installations, as DEER does not include deemed rates of installation.

Figure 28. Measure Installation Decision Tree

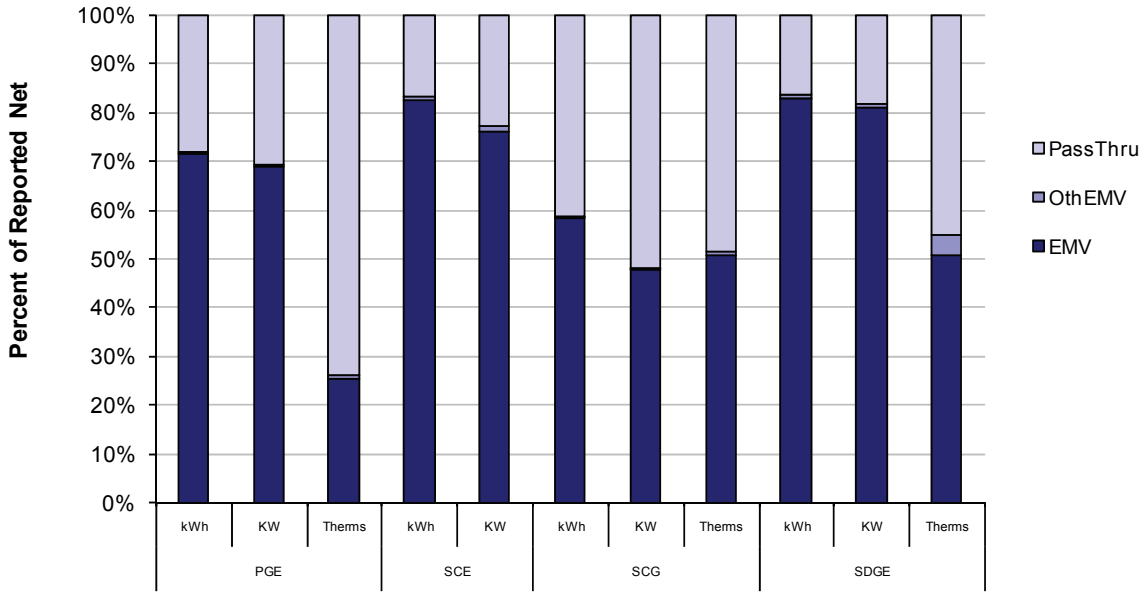


[57] **Applicable**: An evaluated result or value is representative of the population from which it was drawn or is similar in type, application, delivery, and target market. This definition will apply to applicable records and applicable DEER estimates, in both cases the applicability will be documented and deemed defensible by professional evaluators.

[58] As noted in the introduction, these options are specified in D. 07-09-043.

Figure 29 illustrates the outcome of applying the decision tree for installation rates by utility and fuel type. The percentage on the left is the total reported energy savings, and the colors represent the proportion of savings by update type.

Figure 29. Outcomes of Installation Rate Updates by Utility and Energy Type



3.4.2. Program Costs

> *On an annual basis, Joint Staff plans to verify program cost estimates reported by each program administrator and will include non-confidential findings as part of its August 1st verification report. (1-11-06 ALJ Ruling, Attachment 2, p.4.)*

The CPUC Audit report for 2006-2008 program years has been completed. Updates to the E3 filed costs were not adjusted. All costs were found to be allowable; therefore, no updates or adjustments were made to utility reported program costs for the 2006-2008 cycle and these costs were passed through in the E3 calculators in calculation of the cost effectiveness of the programs and portfolios.

3.4.3. Unit Energy Savings /Savings by Program Strategy

> *Utility program administrators have already provided estimates of the unit energy savings by measure or end-use and then used these estimates combined with forecasts of measure installations to develop program level savings estimates. Joint Staff plans to provide interim measure savings results in the first interim performance basis report in March 2008 and to provide final verification of the measure unit energy savings estimates for the entire program cycle in the final performance basis report in March 2010. (1-11-06 ALJ Ruling, Attachment 2, p.4.)*

The 2006-2008 program cycle evaluations included evaluation of the gross and net energy savings accomplishments for 86% of reported kWh, 80% of reported kW and 86% of reported therm savings through the largest programs and key measures. Evaluation results for unit energy savings for all of

the key high impact measures are included in the reports produced by contractors for evaluated program and HIM populations, as is a discussion of the reliability of the results. Unit energy savings in the Upstream Lighting programs and realization rates for large commercial and industrial programs were explained in their respective evaluation reports.

Adjustments to utility claims for unit energy savings that were not directly evaluated (were not part of a program or HIM evaluation design) were considered for update based on the availability of reliable[59] evaluation results from comparable[60] programs or measures targeted at similar customers or delivery mechanisms. The definitions were developed by Energy Division staff in consultation with technical advisors. These cases were limited to 2% of the portfolio for kWh (1% kW and 1% therms). In the case of updating IOU unit energy savings claims, ED staff and contractors considered: [61]

> Option 1.) Extrapolate findings from comparable programs to determine net resource benefits for programs that do not receive full impact evaluation; and
>
> Option 2.) Accept reported savings values for programs that do not receive impact evaluation.

Unit energy savings were treated as a single parameter; therefore extrapolation of these unit energy savings to measures found in other programs had to ensure that the components of this estimate would also likely be comparable (i.e. delta watts or hours of use). ED staff and contractors did not interpret Option 3 (i.e. 3. Extrapolate savings findings from impact evaluations for comparable programs for some net resource benefit parameters and accept reported values for others) to mean that individual components of a parameter estimate can be extrapolated.

Given the time constraints to extract results from prior studies and concerns about comparability with prior studies Energy Division did not consider option 4 for unit energy savings (i.e. 4. Apply a discount factor to savings or costs from programs that do not receive impact evaluation based upon historic impact evaluation results for comparable programs.). Many of the results from the 2004-2005 studies have been reviewed and incorporated into the DEER 2008 update, which will be used to update utility claims as applicable.

If a comparable evaluation result is not available for the unit energy savings for a measure in a given program, a DEER ex-ante update will be considered for DEER measures or customized measures or

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[59] **Reliable**: An evaluated result or value that has met statistical expectations based on the study design and professional evaluators can confidently defend and have fully documented in their evaluation reports.

[60] **Comparable** for the purpose of extrapolating unit energy savings or gross realization rates could be based on several criteria:

- Similar types of customers (e.g., NAIC, SIC, size)
- Similar quality control for measure installations
- Similar building type
- Similar operating hours
- Similar climate

Results from the 06-08 evaluation studies can be extrapolated to other programs or measures in other programs if these criteria are found to be consistent, the evaluation has produced a result that is deemed reliable (by the prior conditions); and evaluation contractors (based on their professional knowledge of the study results) can defend the extrapolation.

[61] As noted in the introduction, these options are specified in D. 07-09-043

customized projects that represent aggregated measures in the E3 calculator as outlined in D. 08-01-042 Ordering Paragraph 3 (see appendix D.).

If none of the preceding update options were available to Energy Division staff, the IOU-reported unit energy savings were passed through

These rules for updating unit energy savings in the 2006-2008 IOU claims were applied based on the following chain of decisions, and evaluation contractors have documented the values applied and justification fro those values Appendix C..

Figure 30. Unit Energy Savings Decision Tree

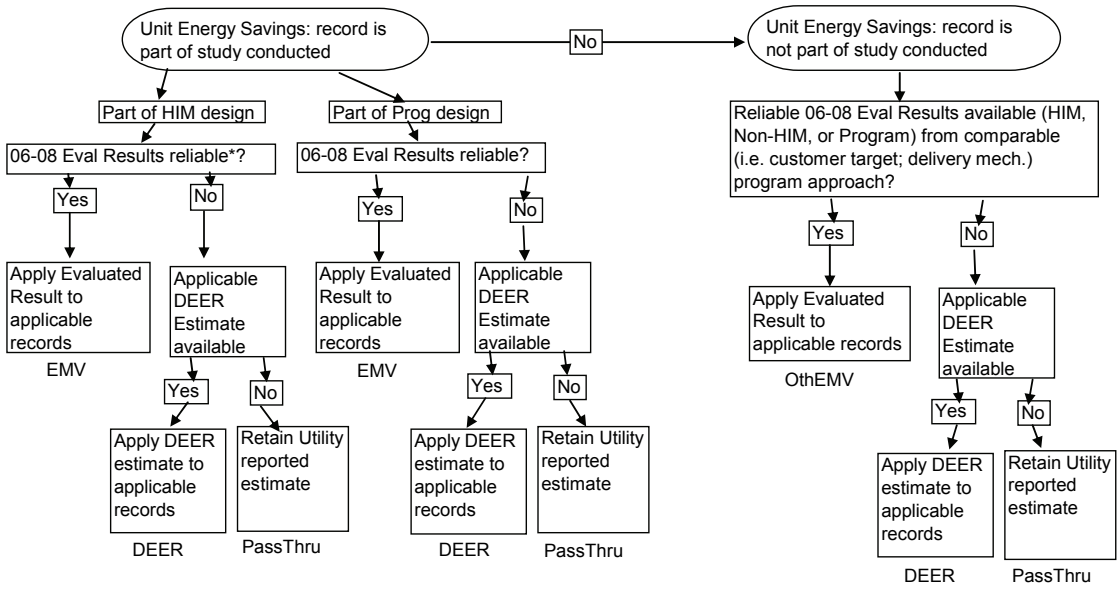
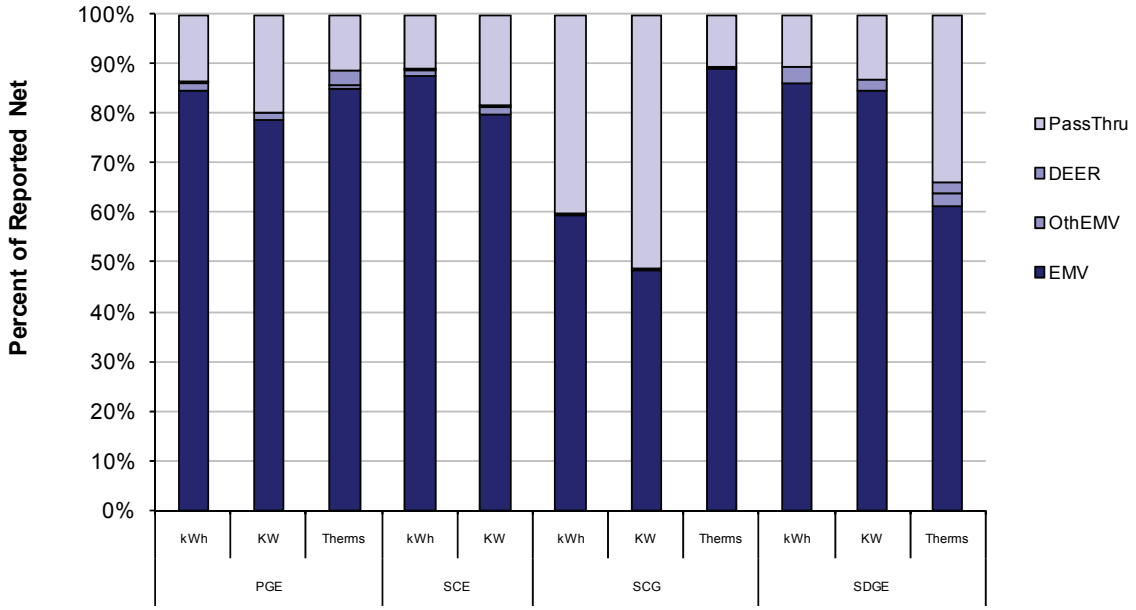


Figure 31 illustrates the outcome of applying the decision tree for unit energy savings by utility and fuel type. The percentage on the left is the total reported energy savings, and the colors represent the proportion of savings by update type.

Figure 31. Outcomes of Unit Energy Savings Updates by Utility and Energy Type



3.4.4. Program level estimates of gross and net Savings

Joint Staff plans to conduct evaluations of the gross and net savings for each program in the utility portfolio. To the extent practicable, those findings will be broken out by program and/or program strategy. Interim results will be presented in the interim performance report in March 2008 and final results in March 2010. (1-11-06 ALJ Ruling, Attachment 2, p.4.)

Energy Division planned evaluations that incorporated 82 programs and included evaluation results for roughly 90 percent of the total kWh, KW and therm savings. Energy Division prioritized the evaluation activities to best capture the key high impact measures (measure that made up >1% of the utility's portfolio savings). Estimates of the unit energy savings by measure or end-use were combined with measure installations to develop program level savings estimates. In light of this approach, there were approximately 90 programs that were not directly evaluated, but the savings from these programs represented only a small portion of the total portfolio. Given the available time to process the results, records associated with non-evaluated programs (and records that were not part of the evaluation plans) were not updated based on the 06-08 evaluation results, or a DEER 2008 update, and the utility claims were passed through.

Energy Division was directed to apply appropriate ex-ante DEER updates to the DEER measures found in those programs that did not have a direct evaluation (or were not part of a HIM study design), or non-evaluated customized measures or customized projects that represent aggregated measures in the E3 calculator per D. 08-01-042 Ordering Paragraph 3 (see appendix D.) However, time constraints did not allow for these updates, and the updates would have had minimal impact on the final results.

3.4.5. Load Factors or Daily Load Shapes for Peak Savings Estimates

Joint Staff plans to estimate the peak load impacts from a variety of programs using the Gross Demand Savings Protocols. These protocols allow the evaluators to use secondary load shape data or primary

interval meter data to estimate peak savings depending on the level of rigor selected by the evaluation team. Joint Staff will make interim results from these studies on an informal basis and then finalize the estimates in the performance basis reports. These peak savings estimates will be available at the same time as the estimates of program energy savings are published. In addition, measure or end-use level savings. The frequency of reports on measure installations (e.g., monthly/quarterly) and the data transfer process (what data is submitted by program administrators directly to Energy Division, what data is sent directly to the EM&V contractors, etc.) will be established by the Reporting Requirements. Estimates may also be produced and reported in the interim or final performance basis reports. (1-11-06 ALJ Ruling, Attachment 2, p.4.)

The 2006-2008 evaluations included evaluation of the gross and net energy savings accomplishments for 80% reported kW savings through the largest programs and key measures. The peak savings estimates were evaluated in accordance with the Gross Demand Impact Protocols[62] and consistent with the definition of peak demand adopted in D.06-06-063 (and compared to DEER 2008 Table 2. *Peak Demand Period Used for DEER 2008* for each climate zone). The evaluation reports completed in February 2010 included final results on peak energy savings from the evaluated program and HIM populations, and a discussion of the reliability of the results. Additionally, profiles of the full year savings (8760) will be provided for measures where data collection was required by either the HIM evaluation plan or site-specific measurement and verification plan. In these cases the data will be submitted in a format consistent with the E3 calculator load shape inputs. However these data will not be used to update load shapes in the E3 calculator for the 2006-2008 evaluation results, but will be valuable for future updates to loadshapes.

Adjustments to utility claims for peak energy impacts that are not being directly evaluated (are not part of a program or HIM evaluation design) were considered with exactly the same guidelines as kWh and therm updates. Please refer to the preceding section "Unit Energy Savings" for the details.

3.4.6. Incremental Measure Costs

Joint Staff plans to verify the utility reported estimates of incremental measure cost on a spot check or sample basis to ensure consistency with the DEER estimates. In addition, Joint Staff plans to review and verify estimates of incremental cost for large industrial and commercial energy efficiency projects where ex ante estimates of incremental costs were not available. (1-11-06 ALJ Ruling, Attachment 2, p.5.)

The evaluations of the 2006-2008 program cycle did not include a review or analysis of incremental measure costs. A comprehensive incremental cost study is necessary but was not part of the evaluation activities in this program cycle. Incremental cost data is not consistently provided at the program tracking level and the estimates provided in the E3 calculator are likely out of date, not always incremental, and pose considerable problems with accurately estimating the cost effectiveness of the portfolios. While a comprehensive review and update of incremental costs is preferable, ED was not able to complete this analysis in time for the draft staff report. IOU filed values for incremental measure costs (from the E3 calculator) were used in the calculations of the cost effectiveness of the portfolios.

Energy Division staff and contractors have developed a method to back cast incremental measure cost data reported by the utilities in the E3 calculator to program tracking records in the standardized tracking database. See Section 3 on the SPTdb for details on that approach.

[62] California Evaluation Protocols, June 2006 p. 32-35

3.4.7. Avoided Costs

Joint Staff will have its contractors verify that utility performance basis calculations utilize the adopted avoided cost time series (per the 2006 Update) whenever administrators are asked to provide an estimate of the performance basis of their portfolio. (1-11-06 ALJ Ruling, Attachment 2, p.5.)

Avoided costs in the E3 filed calculators have been reviewed for consistency with the avoided cost proceeding and have not been modified in the final evaluation results contained in this report.

3.4.8. Expected Useful Lives of Measures

Joint Staff plans to hire contractors to estimate survival functions for a selected set of measures using guidance from the expected useful live protocol. The goal is to estimate survival functions and ultimately useful lives for those measures that are forecast to be responsible for a significant proportion of the portfolio savings but were not covered by the most recent evaluation of useful lives completed in the last three years. These estimates will be used to update the ex ante estimates of useful life for the next program planning cycle but not to update the useful life estimates used in the 2006-2008 program estimates. (1-11-06 ALJ Ruling, Attachment 2, p.5.)

Energy Division hired the DEER team and assigned them to update the EULs, which were then published for both the 2006-2008 ex-ante update as well as the 2010-2012 planning. This work is in line with D. 08-01-042 OP3 (see appendix D), which required an update of the ex-ante EULs. While the Retro-Commissioning contract group did conduct a study regarding the life of retro-commissioning activities, no other evaluation contract group was charged with evaluating effective useful lives of measures.

Lifecycle energy savings that are included in this report simply reflect the first year annual energy savings using the evaluated baseline and multiplied by the effective useful life (EUL). There is no consideration for variable baselines over time due to the market influence of codes and standards that may come into effect sometime in the future, or the variable effect of early replacement programs that would result in greater savings in the earlier years and smaller incremental savings in the later years.

Appendix F provides an example of the possible outcomes for savings by attempting to incorporate the effect of variable savings over time. It explores only one method for illustrative purposes for a handful of custom projects. It is provided to inform future discussion on how to capture long term effects from these programs more accurately.

Most of the existing prescriptive measure and rebate activity in the portfolio continues to be replace on burnout, which means the incremental savings (over code or standard efficiency) for the measure are acceptable to propagate over the effective useful life of that measure. This does not account for changes in the market over time, or changes in code that will occur at some future point in the life of the installed technology (e.g. Huffman bill and compact fluorescent bulbs), though we understand they affect the actual savings on the ground in any given time period.

Evaluation contractors have identified projects in the portfolios that may be classified as early replacement, but only to varying degrees and without consistent tracking data to cross-reference. Early replacement programs or cases mean that a customer replaced equipment before it would have expired on its own, or accelerated the technology adoption. Early replacement cases typically lead to larger savings in the early years due to the larger marginal savings over the existing equipment that was replaced, and lower marginal savings for the period after the existing

equipment would have expired (assuming more efficient products would be available in the market if replaced upon burnout.) Given the lack of information about the early replacement cases for prescriptive measures, Energy Division's contractors only attempted to model early replacement savings for custom projects. The results of the analysis are provided in Appendix F to explain the sensitivity of taking these affects into account, and consideration for future cycles. The results presented in the final ERT input files and the E3 runs reflect a flat long term savings scenario (first year savings * EUL) with first year savings consistent with the gross and net findings presented in the evaluation reports. The component of the net to gross algorithm that considers the effect of the program on early replacement will be included to account for program influence on early replacement in the net savings calculation.

In prescriptive and custom early replacement cases we believe the Commission needs to provide clearer direction on the intent to allow utilities to claim early replacement (for all measures) and subsequent reporting of ex-ante savings must be consistent with early replacement program rules and Commission policy.

To align benefits (savings) with costs in the TRC test (see quotation from the policy manual below), incremental savings and costs in each time period must be accounted for. Reporting from the utilities and studies specifically designed to capture the necessary information are required to be able to model dual baseline scenarios. This was not the case in this program implementation cycle.

> *"The TRC test uses the "incremental" measure cost (not the full cost) and incremental energy savings benefit (not the full energy savings benefit) when an energy-efficient appliance or measure promoted through the program is installed in lieu of the standard (less efficient) appliance/measure that would have been installed, without the utility EE activity. The TRC test uses the full measure cost (at the time of installation) and the full energy savings benefit (of the new measure) for the remaining useful life of the pre-existing equipment (e.g., 3 or more years), where the utility EE activity causes measure/equipment to be replaced much earlier. The TRC test then uses the incremental savings for the balance of the effective useful life of the newly installed measure/equipment and deducts the full cost of that equipment discounted back to the date of the measure/equipment installation. [Policy Manual V4.0 ; page 8 footnote 9]*

Figure 32. EUL Decision Tree

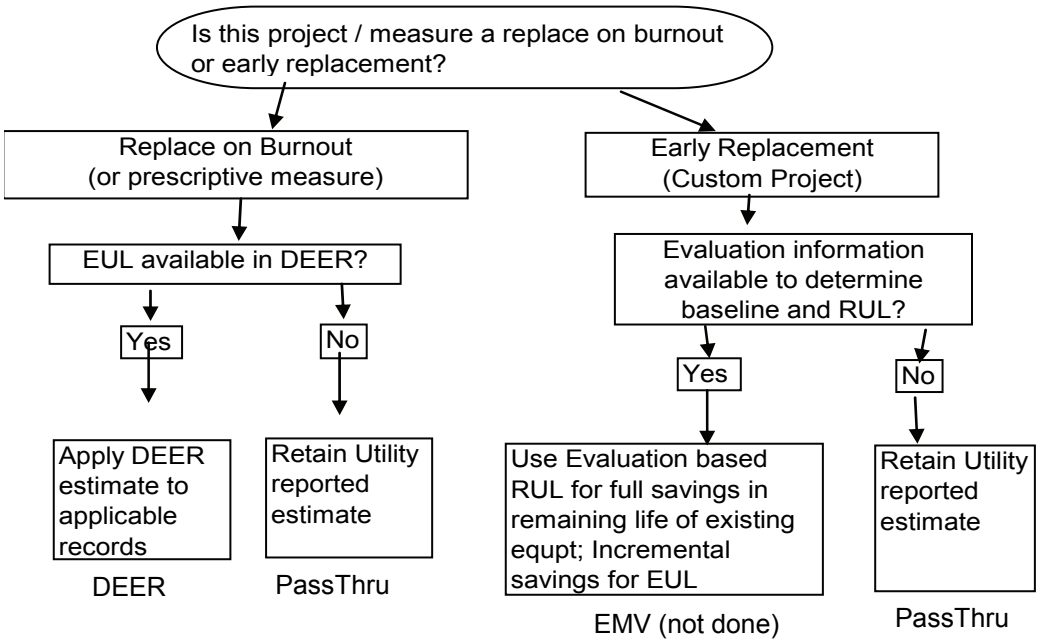
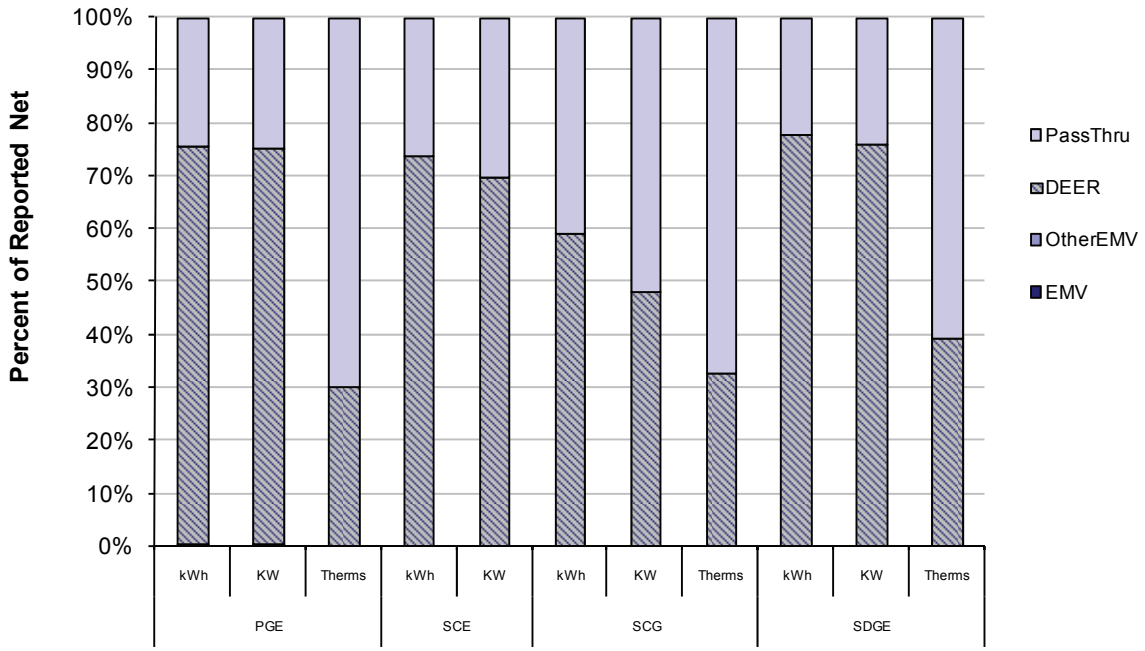


Figure 33 illustrates the outcome of applying the decision tree for expected useful life updates by utility and fuel type. The percentage on the left is the total reported energy savings, and the colors represent the proportion of savings by update type. There are three cases from non-residential new construction that define the update to EUL as "EMV" but this is to reflect corrections to the tracking data assigned EUL.

Figure 33. Outcomes of EUL Updates by Utility and Energy Type



3.4.9. Net to Gross Ratio

Joint Staff plans to estimate net-to-gross ratios for each of the program delivery strategies as part of its load impact evaluations for each of the major program strategy groupings. In some cases, the net-to-gross ratios will also be reported for specific measures and or end-uses associated with a given delivery strategy, as appropriate. For example, the net-to-gross ratio for a downstream rebate program focused on increasing the sales of compact fluorescent lamps, might be available for a given program year, say 2006, but would need to be updated at the end of the program cycle to account for any changes in program delivery strategies in 2007 or 2008. The availability of these net-to-gross estimates is closely linked to the schedule for releasing estimates of gross and net program energy savings in the interim and final performance basis reports. These net-to-gross ratios will be combined with estimates of gross energy savings to yield net program savings estimates in the interim and final performance basis reports. (1-11-06 ALJ Ruling, Attachment 2, p.5.)

For the 2006-2008 portfolio approximately 90% of kWh, 85% kW and 91% of therms had a direct evaluation result for program attribution (NTGR). Evaluation results for net to gross (NTG) ratios for high impact measures and directly evaluated programs were included in the final contractor reports along with a discussion of the reliability of the results. Contractors reported NTG ratios for each fuel type (kWh, kW, and Therms) in the study population.

Adjustments to utility deemed NTG ratios that were not directly evaluated (were not part of a program or HIM evaluation design) made up only 1% of kWh, kW and therm savings. These updates were considered based on the availability of **reliable**[63] evaluation results from **comparable**[64] programs or measures targeted at similar customers or delivery mechanisms. These definitions were developed by Energy Division staff in collaboration with MECT and DMQC advisors. In the case of updating IOU net to gross claims ED staff and contractors considered:[65]

> Option 1.) Extrapolate findings from comparable programs to determine net resource benefits for programs that do not receive full impact evaluation; and

[63] **Reliable**: An evaluated result or value that has met statistical expectations based on the study design and professional evaluators can confidently defend and have fully documented in their evaluation reports.

[64] **Comparable**: for the purpose of extrapolating net to gross ratios will be based on several criteria:

Situation #1	Situation #2	Situation #3
NTGR (other measures or projects within a given program) ▪ Similar rebate as a percent of incremental cost ▪ Similar types of customers (e.g., NAIC, SIC) ▪ Similar size of customer (annual kWh consumption)	NTGR (within the same IOU) ▪ Similar implementation strategy ▪ Similar rebate as a percent of incremental cost ▪ Similar types of customers (e.g., NAIC, SIC) ▪ Similar size of customer (annual kWh consumption)	NTGR (across IOU) ▪ Similar implementation strategy ▪ Similar rebate as a percent of incremental cost ▪ Similar types of customers (e.g., NAIC, SIC) ▪ Size of customer (annual kWh consumption) ▪ Similar economic environment - Similar cost of living

Results from the 06-08 evaluation studies can be extrapolated to other programs or measures in other programs if these criteria are found to be consistent, the evaluation has produced a result that is deemed reliable (by the prior conditions); and evaluation contractors (based on their professional knowledge of the study results) can defend the extrapolation.

[65] As noted in the introduction, these options are specified in D. 07-09-043

Option 2.) Accept reported savings values for programs that do not receive impact evaluation.

Given time constraints to extract results from prior studies and concerns about comparability with prior studies ED did not consider option 4 for net to gross ratios (i.e., 4. Apply a discount factor to savings or costs from programs that do not receive impact evaluation based upon historic impact evaluation results for comparable programs.).

If a comparable evaluation result was not available for the net to gross ratio for a measure in a given program or a program, a DEER ex-ante update was considered for DEER measures or customized measures or customized projects that represented aggregated measures in the E3 calculator as outlined in D. 08-01-042 Ordering Paragraph 3 (see appendix D.). This type of update was only applied to 1% of kWh, 1% kW and 1% therm savings.

If none of the preceding update options were available to Energy Division staff, the utility-reported NTG ratio was passed through.

These rules for updating net to gross ratios in the 2006-2008 utility claims were applied based on the following chain of decisions.

Figure 34 illustrates the outcome of applying the decision tree for net to gross ratio updates by utility and fuel type. The percentage on the left is the total reported energy savings, and the colors represent the proportion of savings by update type.

Figure 34. Outcomes of NTGR Updates by Utility and Energy Type

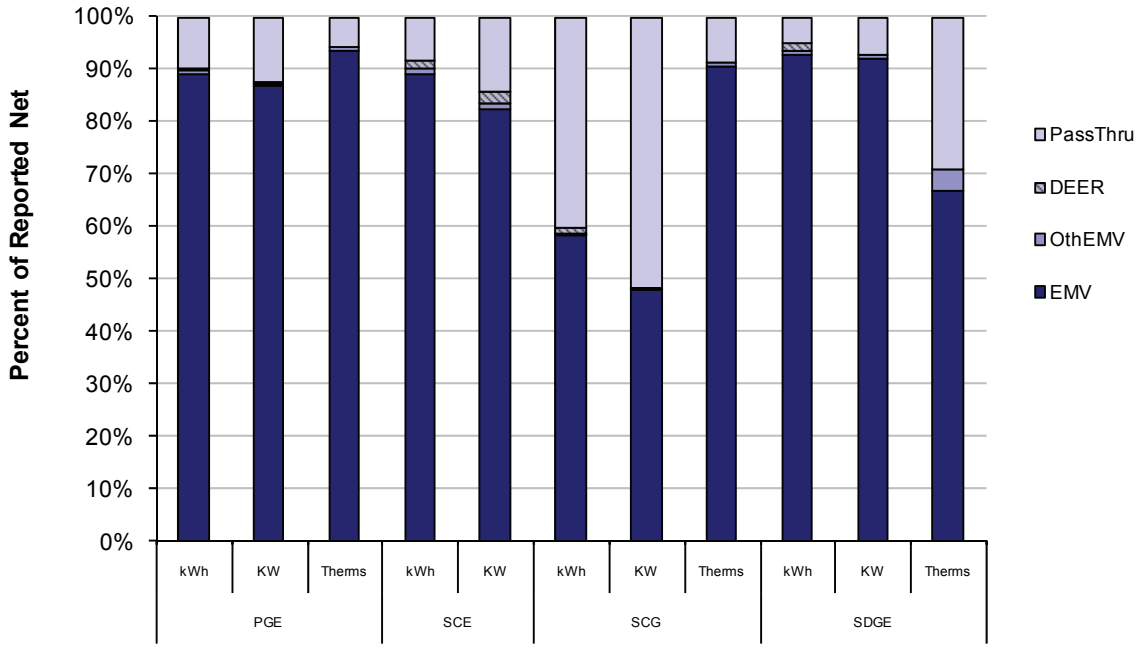
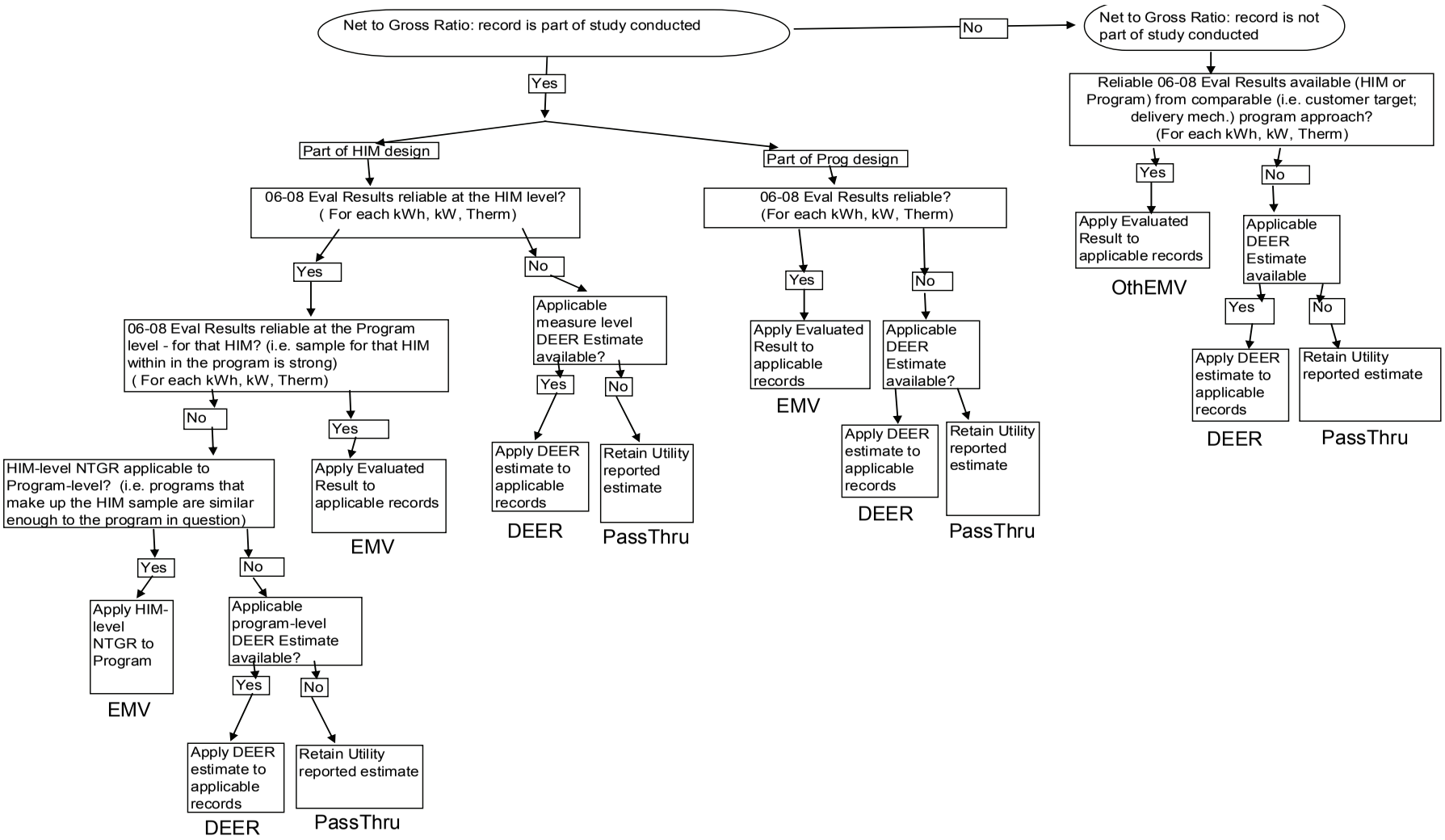


Figure 35. Net to Gross Decision Tree



4. ENERGY SAVINGS RESULTS

The final evaluated energy savings for the 2006-2008 energy efficiency program cycle are presented in this section by IOU, market segment, program and technology or measure. Finally, a comparison of the energy savings goals adopted by the Commission for the program cycle, the energy savings reported by the utilities, and the evaluated results is included in the section.

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 improvements in energy efficiency translate into quantifiable energy savings when compared against a baseline. The term "measures" captures both the installation of specific technologies and other program interventions that lead to improvements in energy efficiency.

The evaluated energy savings presented in this section include the net and gross savings as well as annual and lifecycle savings. Measuring gross savings means establishing the savings that were achieved by all of the measures that were installed, and net savings describe the free-ridership[66] that may be occurring within energy efficiency programs and the influence of the programs on customer decisions. Annual savings represent the energy impacts of the installed technologies for the year in which they are installed. The lifecycle savings reflect the total savings achieved by installed technologies over the expected useful life of those technologies, assuming they remain in place for that period and continue to save energy. Lifecycle savings can also be expressed in "gross" and "net" terms. With the exception of Table 18, all of the tables in this section represent net savings.

The evaluation results concluded that program participants achieved approximately 6,494 GWh, 1,175 MW and 84 million therms in gross annual impacts. Over 4,639 GWh, 852 MW and 30 million therms in net annual savings for the 2006 - 2008 program cycle were directly attributable to the influence of the programs.

Table 18. Savings Impacts from 2006-2008 IOU Energy Efficiency Investments

	Annual Impact		Lifecycle Impact		% of 2008 sales
	Gross	Net	Gross	Net	Gross
GWh	6,497	4,097	66,142	42,736	3.2%
MW	1,175	779			
MMTherm	84	44	1,378	690	1.0%

The energy savings estimates presented in this section are also presented as point estimates. Energy Division conducted a portfolio level analysis of the confidence intervals. It is based on the statistic confidence intervals for the evaluation-based parameter updates, which are described in the documentation provided by the evaluation contractors in Appendix C. The analysis and results are described in the following section. In addition, other sources of uncertainty, including

[66] Free riders (Free Ridership) Program participants who would have installed the program measure or equipment in the absence of the program. ENERGY EFFICIENCY POLICY MANUAL, VERSION 4.0 (July 2008).

measurement error, were considered as part of the evaluation studies and design, but these uncertainties have not been quantified across the portfolio.

The remainder of this section presents the portfolio confidence interval analysis, the energy savings by market sector and specific measures to illustrate where the impacts were achieved in the 2006-2008 program cyle.

4.1 IOU Portfolio Confidence Intervals

Most of the estimated net energy and demand impacts included in this report are based on samples of program installations which received ex post EM&V. This section presents confidence intervals for the net kWh, kW, and therm savings for each IOU's 2006-08 portfolio. No targeted precision has ever been established in any CPUC decision at the portfolio level and there is no requirement in the CPUC-adopted Protocols to report any achieved relative precision at the portfolio level; Energy Division provides this analysis for informational purposes. It is also important to note that a focus on statistical relative precision reflects a failure to understand that reducing sample error to the exclusion of reducing measurement error is a mistake. Having unbiased program-level estimates is equally, perhaps more, important than having precise program-level estimates. Energy Division and the evaluation contractors recognized the importance of both and attempted to balance these concerns in their evaluations.

Preliminary IOU-specific confidence intervals were prepared by Energy Division based on the impact evaluations completed for the 2006-08 program cycle and following a methodology described in the California Evaluation Framework.[67] Energy Division developed this analysis, which was not part of the ERT design, with the support of technical contractors by synthesizing information from the impact evaluations. Energy Division emphasizes that the intervals represent reasonable approximations based on available information. A more detailed and comprehensive analysis is unlikely to change the results substantially.

Results

Table 1 presents the results of the analysis including the savings estimate for each IOU and the upper and lower bounds of the confidence interval. This analysis used only those observations for which the HIM UES was estimated via ex post EM&V. Measures that were not evaluated, were passed through, or were DEER-based were not taken into consideration since they were not subject to sampling error, i.e., they relied on deemed savings, which do not have an error band.

Column 1, *First-Year Annual Net Impacts*, represents the net evaluated energy and demand impacts of each IOU's 2006-08 energy efficiency portfolio. The second column, *90% Relative Precision*, is the 90% error bound for the estimated portfolio savings, $1.645\ sd(\hat{\mu})$, divided by the estimated portfolio savings, expressed as a percentage. Columns 3 and 4, the *Upper Bound* and the *Lower Bound*, represent the 90% confidence interval ($E(\hat{\mu}) \pm 1.645\ sd(\hat{\mu})$) surrounding the estimated impacts in

[67] "The California Evaluation Framework" available at: http://www.calmac.org/publications/California_Evaluation_Framework_June_2004.pdf . Note: The method described on page 300 applies even though this evaluation focused on HIMs within a portfolio rather than programs.

column 1, expressed in absolute units. The non-technical interpretation is that there is a 90% chance that the true net savings from the portfolio falls in the computed confidence interval.

The estimates of 90% relative precision are all less than 8% except for therms for both PG&E and SoCal Gas. This high level of precision reflects the fact that the standard deviation of a sum is not simply the sum of the standard deviations, but, in the simplest case, it is the square root of the sum of the squared standard deviations. Each study may have had larger or smaller error bounds, but when combined, the relative precision of the total savings may be better than that of any of the individual studies.

Table 19. Evaluated Savings, 90% Relative Precision and Confidence Intervals, by IOU

		Total Portfolio Net Savings	90% Relative Precision	Upper Bound	Lower Bound
PG&E	**GWh**	1,766	±4.51%	1,846	1,686
	MW	320	±3.21%	330	310
	Therms	22	±13.47%	25	19
SCE	**GWh**	1,963	±5.88%	2,078	1,848
	MW	384	±3.00%	396	372
SoCal Gas	**Therms**	32	±14.63%	37	27
SDG&E	**GWh**	364	±7.67%	392	336
	MW	72	±6.10%	76	68
	Therms	3	±5.91%	3	3

Methods

This analysis used only those observations for which the UES was estimated via ex post EM&V. Measures that were not evaluated, were passed through, or were DEER-based were not taken into consideration since they were not subject to sampling error, i.e., they relied on deemed savings. Equations 1 through 4 are based only on net savings estimated via ex post EM&V.

The net first-year impacts for kWh, kW, and therms for a given HIM are the result of the following basic equation:

$$\text{Net Impacts}_{HIM} = (IR \times \text{IOU Claimed Installations}) \times UES \times NTGR \quad (1)$$

Where

IR=Ex post installation rate
UES=Ex post gross unit energy savings[68]
NTGR=Ex post net-to-gross ratio

[68] The relative precision associated with a given UES includes, as appropriate, the propagation of errors across parameters involved in its calculation.

First, for each of the three parameters (IR, UES, and NTGR), the 90% relative precision is calculated. Next, the 90% relative precision of the net HIM savings are calculated in a way that, using Equation 2, takes into account the propagation of error involved in multiplying these three parameters.

$$RP\ \text{HIM Net Savings} = \sqrt{rp(IR_{HIM})^2 + rp(GS_{HIM})^2 + \text{rp}(\text{NTGR}_{\text{HIM}})^2} \quad (2)$$

where

$rp(IR_{HIM})$ =the 90% relative precision of the installation rate

$rp(GS_{HIM})$ = the 90% relative precision of the UES

$rp(NTGR_{HIM})$ = the 90% relative precision of the NTGR

The error bound of the HIM net savings was then calculated using Equation 3:

$$EB_{HIM} = NS_{HIM} \times RP\ \text{HIM Net Savings} \quad (3)$$

where

EB_{HIM} = the 90% error bound of net savings for a HIM

NS_{HIM} = the net ex post savings for a HIM

Once the error bound of net savings for each of the HIMs in a given IOU portfolio is calculated, the error band for the portfolio can be calculated across all HIMs using Equation 4:

$$EB_{Portfolio} = \sqrt{(\text{EB HIM}_1)^2 + (\text{EB HIM}_2)^2 ..... + (\text{EB HIM}_n)^2} \quad (4)$$

Equation three is based on the following three assumptions:

1. There are no interactions between the HIMs,
2. Each of the individual HIMs has been evaluated independently,
3. Each evaluation has provided an unbiased estimator of the actual savings of the corresponding HIM, and

The result is a simple consequence of (a) the fact that the standard deviation of a sum of statistically independent random variables (e.g., the estimated savings of each program) is the square root of the sum of the squares of the standard deviations of each of the random variables, and (b) the error bound being defined as 1.645 times the standard deviation.

Finally, the relative precision of the portfolio was calculated using Equation 5:

$$RP_{Portfolio} = \frac{EB_{Portfolio}}{NS_{Portfolio}} \quad (5)$$

where

$EB_{Portfolio}$ =The error band of the portfolio. Note that only the net savings estimated via ex post EM&V are included in $EB_{Portfolio}$. It excludes net savings from measures whose parameters were not evaluated, were passed through, or were DEER based. It also excludes interaction effects.

$NS_{Portfolio}$ =The net impacts (kWh, kW or therms) of the portfolio. Note that $NS_{Portfolio}$ includes all net savings, i.e., the net savings estimated via ex post EM&V as well as the net savings from measures whose parameters were not evaluated, were passed through, or were DEER based. It also includes interaction effects.

Further examples of this methodology can be found in the *California Evaluation Framework*, page 300.

4.2. Energy Savings by Utility, Market and Measures

One way to understand the impact of these savings on California is to see where the savings have accrued. The proportion of savings by market sector and the total by utility are presented in the following table. The majority of energy savings, both statewide and for each IOU, is concentrated in the residential and commercial market sectors.

The evaluations conducted in the 2006-2008 period considered all fuel impacts of the installed measures. Consequently, electric impacts are reflected for SCG and natural gas impacts are shown for SCE. These impacts are not considered compared to goals, since neither utility has goals for energy types it does not sell. The negative natural gas savings in the residential sector for all utilities is due to the effect of the installation of interior lighting and refrigeration measures that increase internal heating load.

Figure 36. Electric and Natural Gas Savings by Market Distribution

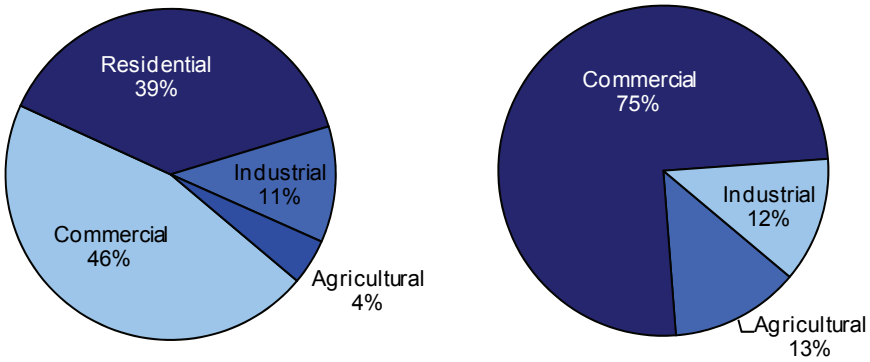


Figure 37. Electric and Natural Gas Savings by Measure Group

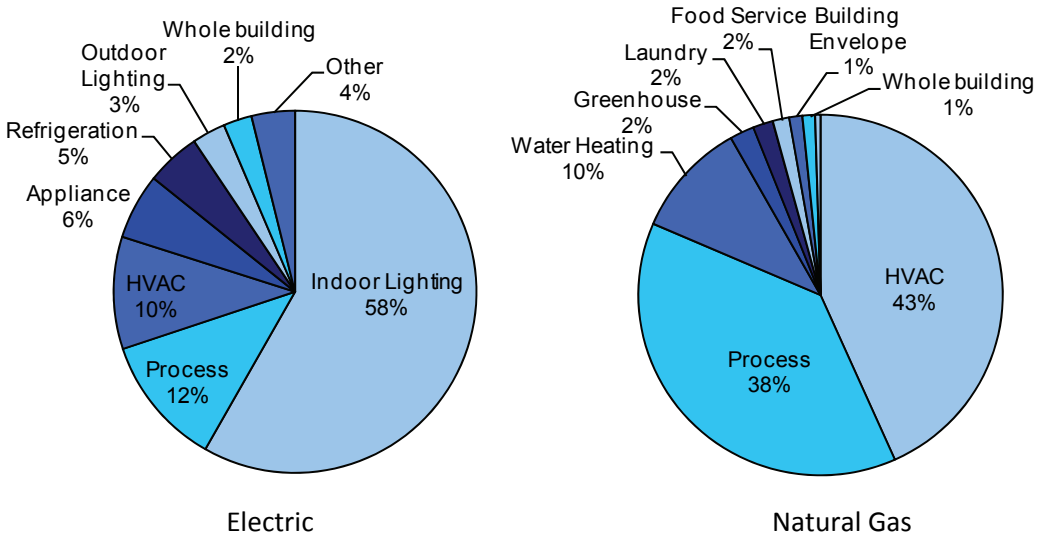


Table 20. Evaluated Annual and lifecycle energy savings by IOU and Market Sector

		NET Annual			Lifecycle	
	Market Segment	**GWh**	**MW**	**MMTherms**	**GWh**	**MMTherms**
PGE	Residential	37%	32%	-38%	30%	-9%
	Industrial	7%	5%	33%	11%	36%
	Commercial	49%	57%	71%	48%	39%
	Agricultural	7%	7%	34%	10%	34%
		1,766	**320**	**22**	**18,538**	**411**
SCE	Residential	41%	37%	90%	34%	86%
	Industrial	17%	14%	2%	23%	3%
	Commercial	38%	45%	8%	39%	11%
	Agricultural	3%	4%	0%	4%	0%
		1,963	**384**	**-13**	**20,029**	**-102**
SCG	Residential	80%	96%	11%	89%	13%
	Commercial	20%	4%	89%	11%	87%
		4	**3**	**32**	**69**	**344**
SDGE	Residential	28%	28%	9%	23%	18%
	Industrial	0%	0%	8%	0%	5%
	Commercial	72%	72%	76%	77%	75%
	Agricultural	0%	0%	7%	0%	3%
		364	**72**	**3**	**4,100**	**37**
	Residential Sum	38%	34%	-38%	31%	-11%
	Industrial Sum	11%	9%	17%	15%	21%
	Commercial Sum	46%	52%	104%	47%	69%
	Agricultural Sum	4%	5%	18%	6%	20%
Grand Total		**4,097**	**779**	**44**	**42,736**	**690**

The energy efficiency measures that are responsible for the majority of the savings in the 2006-2008 cycle are found in the residential sector, primarily lighting, as shown in the following table. This table shows which measure groups contributed to the majority of savings for each market sector.

Again negative gas savings values reflect the impact of effect of interior lighting and refrigeration measures that increase internal heating load.

Table 21. Annual and Lifecycle Energy Savings by Market Sector and Measure Group

		NET Annual			Lifecycle	
Market	**Technology**	**GWh**	**MW**	**MMTherms**	**GWh**	**MMTherms**
Residential	Indoor Lighting	74.0%	50.9%	113.2%	66.2%	164.9%
	Appliance	15.0%	15.4%	30.7%	18.3%	67.7%
	HVAC	3.9%	24.2%	-6.3%	4.5%	-26.1%
	Outdoor Lighting	3.8%	0.7%	-	7.1%	-
	Laundry	1.0%	-	-5.5%	1.3%	-13.2%
	Water Heating	1.0%	3.0%	-25.6%	1.2%	-65.7%
	Building Envelope	0.3%	2.5%	-4.7%	0.6%	-20.5%
	Whole building	0.3%	1.6%	-1.7%	0.6%	-6.8%
	Survey	0.7%	1.5%	-	0.3%	-
Residential Total		**1,578**	**267**	**(17)**	**13,375**	**(76)**
Industrial	Indoor Lighting	22.1%	30.2%	-3.3%	20.4%	-2.0%
	HVAC	4.4%	4.0%	6.8%	4.5%	4.5%
	Outdoor Lighting	0.3%	0.2%	-	0.2%	-
	Building Envelope	0.4%	0.3%	-	0.5%	-
	Whole building	5.4%	4.7%	-	7.4%	-
	Survey	3.5%	5.3%	-	0.7%	-
	Other	1.2%	1.1%	0.1%	1.2%	0.1%
	Process	61.4%	53.4%	96.1%	63.6%	97.1%
	Refrigeration	1.0%	0.6%	-	1.1%	-
Industrial Total		**465**	**69**	**7**	**6,596**	**146**
Commercial	Indoor Lighting	58.2%	57.9%	-5.7%	54.2%	-5.0%
	Appliance	0.2%	0.1%	-	0.1%	-
	HVAC	17.5%	26.6%	62.1%	20.7%	45.4%
	Outdoor Lighting	3.2%	0.6%	-	4.0%	-0.1%
	Water Heating	0.1%	0.1%	6.0%	0.1%	5.8%
	Building Envelope	0.6%	0.8%	0.1%	0.6%	0.1%
	Whole building	3.4%	4.1%	1.0%	4.7%	1.4%
	Plug Loads	1.5%	0.4%	-	1.1%	-
	Process	4.2%	2.7%	30.9%	5.6%	47.5%
	Food Service	0.8%	0.5%	2.3%	0.9%	2.6%
	Greenhouse	-	-	2.0%	-	1.0%
	Refrigeration	8.9%	4.8%	0.1%	6.9%	-
Commercial Total		**1,873**	**407**	**45**	**20,000**	**478**
Agricultural	Indoor Lighting	13.0%	7.5%	-	13.2%	-
	HVAC	2.8%	3.1%	11.1%	2.7%	11.9%
	Outdoor Lighting	0.4%	0.5%	-	0.3%	-
	Water Heating	0.4%	0.5%	3.9%	-	2.7%
	Building Envelope	0.2%	0.1%	-	0.2%	-
	Whole building	6.0%	2.4%	1.0%	6.9%	0.8%
	Process	61.8%	79.1%	76.0%	60.9%	81.8%
	Greenhouse	0.1%	-	8.1%	-	2.8%
	Refrigeration	14.8%	6.7%	-	15.4%	-
Agricultural Total		**183**	**38**	**8**	**2,770**	**141**
Grand Total		**4,093**	**779**	**44**	**42,718**	**690**

4.3. Measure Specific Results

The IOU programs implement programs that promote specific energy saving technologies or measures in order to produce energy savings. In the 2006-2008 portfolio fourteen measure groups were responsible for over 90 percent of the reported statewide electricity. These typically were the key measures for any given IOU (with some slight variance for SCG). These measures were:

Interior screw lighting	Refrigerant Charge and Airflow
Linear fluorescent	High bay fluorescent lighting
Recycle refrigerator	Refrigeration Door gasket
Outdoor CFL Fixture	Night light
Refrigeration strip curtain	Lighting – other
CFL Fixture	Linear fluorescent delamping
On-site Audit	Rooftop or split system

There were 12 measure groups that made up over 90 percent of the statewide natural gas savings. These technologies were:

Steam trap	Water heater
Pipe and tank insulation	Furnace
Clothes washer	Food Service
Greenhouse heat curtain	Process boiler
Insulation	Greenhouse IR film
Water heater control	Duct sealing and insulation

Measures found in the groups listed above often made up greater than 1 percent of any given utility's savings and therefore were evaluated as a "high impact measure". This meant that the evaluations, in some cases, crossed programs to improve sample sizes for these particular measures and gain a more robust estimate of the savings. The specific study designs, and limitations, are articulated in the evaluation reports completed in February 2010. Table 22 illustrates the ratio of reported savings (prior to the 2006-2008 field study) for these technologies compared to the evaluated savings after the studies were completed. This ratio is commonly referred to as a realization rate. This particular table is based on the average unit energy savings for these specific measure groups, and the information presented is also available at the program tracking record level in the ERT input files.

Realization rates for these measure groups provide the foundation for understanding the comparative results shown in section 4.4 between the evaluated and utility reported savings. In isolation, these realization rates do not convey qualitative information about the relative value of energy efficiency savings as compared to other resource options. Neither a high or a low realization rate provide information on the absolute size of value of the energy efficiency impacts, simply a comparison of the savings estimates available before the program started and after field evaluation was conducted.

Note that the measure group that made up the largest portion of the portfolio, interior screw lighting, also had one of the lowest realization rates. The reasons for this are outlined in the Residential Upstream Lighting evaluation summary in section 2. Measure groups that were the source of significant reported natural gas savings also exhibited some very low realization rates for the most significant measure groups in the portfolios. The list of measure groups in Table 22 and

Table 23 include a subset of measures that made up the majority of savings in the 2006-2008 program cycle.

Table 22. Gross and Net Realization Rates for Key Electric Measure Group

Technology Group	Gross-kWh	Gross-kW	Net- kWh	Net-kW
Interior screw lighting	37%	39%	26%	27%
Linear fluorescent	77%	88%	68%	78%
Recycle refrigerator	66%	69%	73%	74%
Process - unknown	66%	67%	48%	49%
Outdoor CFL Fixture	42%	3336%	41%	3010%
CFL Fixture	55%	52%	53%	49%
Refrigeration strip curtain	57%	32%	38%	27%
High bay fluorescent	69%	62%	57%	51%
Process - other	68%	62%	53%	48%
Lighting - unknown	92%	86%	85%	80%
Linear fluorescent delamping	69%	77%	62%	69%
Pump off controller	48%	48%	28%	28%
Pump	78%	90%	63%	74%
On-site Audit	31%	33%	20%	23%
RCA	47%	42%	46%	41%
WB - NC	99%	93%	83%	82%
Refrigeration Door gasket	19%	21%	16%	17%
Compressed air	65%	65%	55%	54%
Lighting - other	65%	96%	54%	82%
Night light	37%	0%	36%	0%
VFD - application unknown	74%	71%	64%	63%
Chiller	84%	85%	72%	75%
Retro commissioning	68%	65%	66%	60%
Rooftop or split system	61%	82%	59%	81%

Table 23. Gross and Net Realization Rates for Key Natural Gas Measure Group

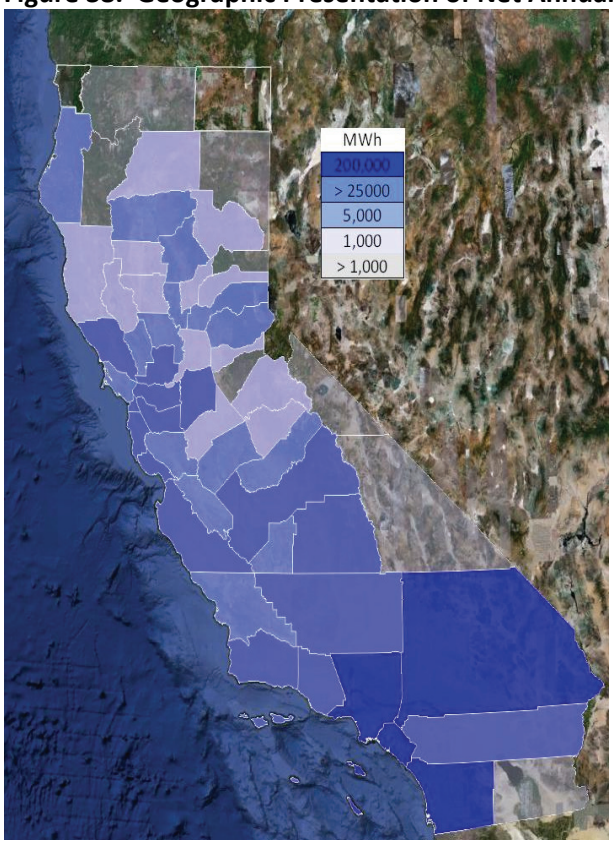
Technology Group	Gross-Therm	Net-Therm
Process - other	58%	39%
Steam trap	167%	92%
Pipe and tank insulation	22%	15%
Process boiler	70%	39%
Process - unknown	83%	39%
Heat recovery	68%	47%
Clothes washer	56%	28%
Greenhouse heat curtain	64%	42%
Heating Boiler	91%	79%
Water heater control	100%	100%
Insulation	86%	33%
Water heater	92%	52%
Duct sealing and insulation	64%	40%

4.4. Geographic Distribution of Savings Statewide

The energy savings accrued to customers in the four utility territories, and the accumulated savings (i.e. benefits) varied by county. The map in **Error! Reference source not found.**. illustrates this

variation across California's counties, and the accompanying table shows which counties had the most significant electric savings. The fowllowing two figures show the same information for peak and natural gas savings. These graphics are a starting point to show the range of possibilities with a centralized database of savings to understand the impacts of energy efficiency in the state.

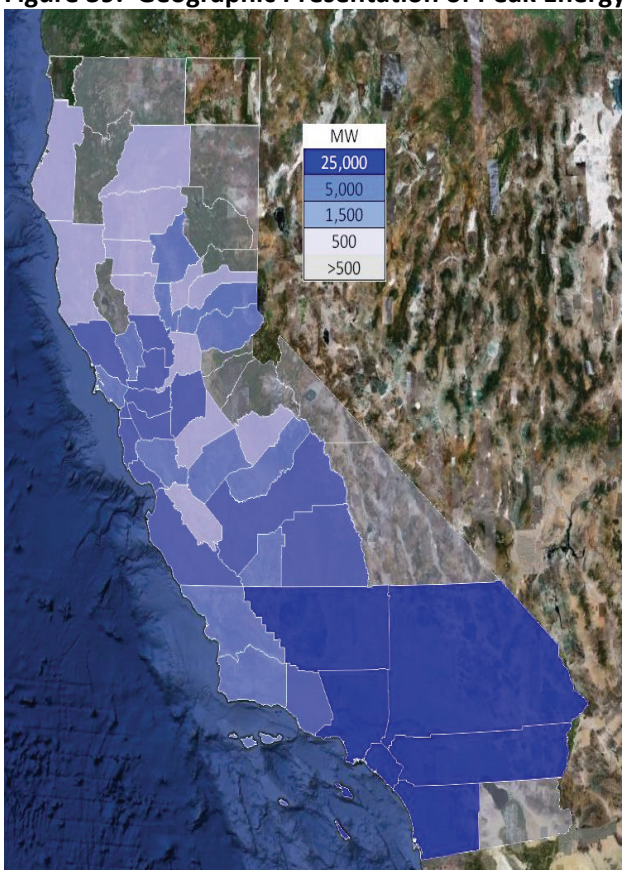
Figure 38. Geographic Presentation of Net Annual Electric Energy Savings Statewide



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 39. Geographic Presentation of Peak Energy Savings Statewide

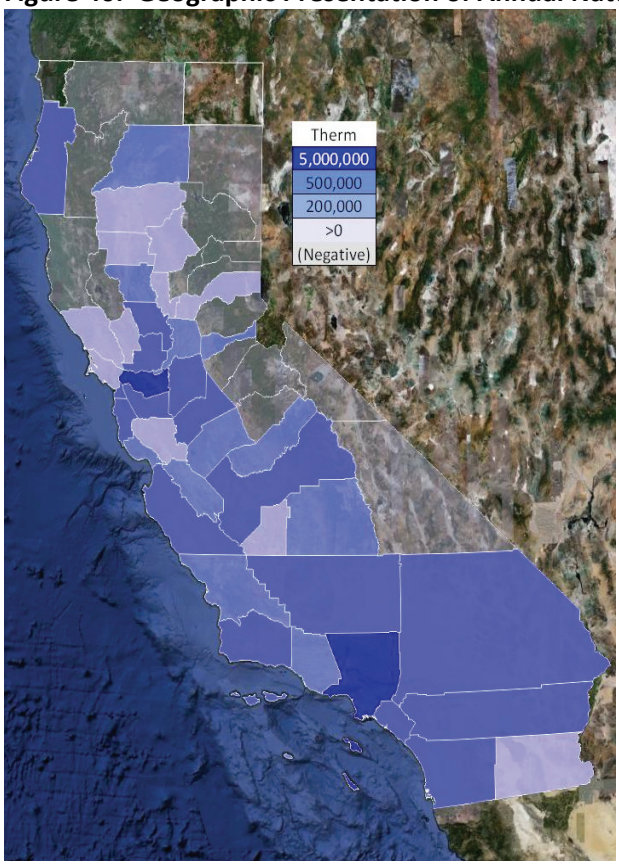


County	kW Savings
LOS	99,021
ORANGE	56,318
SAN	54,201
SAN	53,665
RIVERSIDE	37,739
KERN	25,969
ALAMEDA	24,556
FRESNO	21,291
SANTA	18,743
SAN	18,171
CONTRA	15,426
TULARE	15,208
VENTURA	13,372
SAN	11,809
SAN	7,147
SOLANO	6,790
YOLO	6,358
SONOMA	6,094
MONTEREY	5,806
PLACER	4,486
LOS	99,021

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 40. Geographic Presentation of Annual Natural Gas Savings Statewide



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

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

4.5. Comparative Results to Goals, Reported and Evaluated

This section presents a comparison of the evaluated energy savings achievements as they relate to the energy savings goals adopted by the Commission for the 2006-2008 program cycle and the energy savings reported by the IOUs for the program cycle. The distinction between evaluated energy savings, IOU-reported savings and energy savings goals adopted by the Commission are as follows:

- Goals[69] - Energy savings targets established by the Commission for IOU programs in the 2006-2008 program cycle, as well as cumulative goals for 2004-2008. These goals have an annual, program cycle and multi-cycle cumulative dimension. The current goals are based on historical energy efficiency savings assumptions.

- Utility Reported Savings - Energy savings were based on the utility records of installed technologies and the savings from those technologies based on pre-evaluation assumptions.

- Evaluated Savings - Energy savings based on field research of the installations that were reported during the 2006-2008 program cycle.

In the following two tables the evaluated saving are presented in comparison to the savings goals for the program cycle (2006-2008) and for the cumulative goals period (2004-2008).

Combined, the utilities achieved roughly 70 percent of the statewide electric goals, and 63 percent of both the MW and MMtherm goals in the 2006-2008 program implementation period.

The energy efficiency savings goals that are in effect for the 2006-2008 cycle were developed from analyses conducted from 2002 to 2004. 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 may lead to differences 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. The CPUC deliberately set challenging energy efficiency goals for the IOUs' 2006-2008 programs.It appears that market forces are contributing to a larger share of energy savings than were forecasted in the studies used to inform the CPUC's goals, based on the high net to gross ratios identified in the impact studies. Because Energy Division's evaluations are charged with estimating savings that are directly attributable to the utilities' programs, increases in market driven adoption of efficiency measures can result in a lower level of estimated savings for utility programs even though total societal savings from both utility program and market forces are significant.

[69] The goals that are currently in place were adopted in D. 04-09-060; September 23, 2004, were based on the data available at the time; and were considered "stretch goals." http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/40212.pdf

Table 24. Comparative of Program Cycle 2006-2008 Evaluated Results to Goals

	PGE	SCE	SDGE[70]	SoCalGas	Total
Savings Goals			**PY 2006-2008**		
Cumulative Savings (GWH)	2,826	3,135	638		6,599
Peak Savings (MW)	613	672	122		1,407
Cumulative Natural Gas Savings (MMTh)	45		10	57	112
EE Portfolio Savings (Reported)			**PY 2006-2008**		
Cumulative Savings (GWH)	5,251	3,898	850		9,999
Peak Savings (MW)	845	690	147		1,682
Cumulative Natural Gas Savings (MMTh)	66		7	67	140
EE Portfolio Savings (Evaluated)			**PY 2006-2008**		
Cumulative Savings (GWH)	1,766	1,963	364	0	4,093
Peak Savings (MW)	320	384	72	0	776
Cumulative Natural Gas Savings (MMTh)	22	0	3	32	57
50% C&S Savings (Evaluated)**			**PY 2006-2008**		
Cumulative Savings (GWH)	157	162	37	0	356
Peak Savings (MW)	30	31	7	0	68
Cumulative Natural Gas Savings (MMTh)	2	0	0.2	3	6
EM&V Adjusted LIEE* Savings			**PY 2006-2008**		
Cumulative Savings (GWH)	79	74	16		169
Peak Savings (MW)	16	16	4		36
Cumulative Natural Gas Savings (MMTh)	4		1	3	8
Performance against 2006-2008 goal					
Percent of GWH Goal	71%	70%	65%		70%
Percent of MW Goal	60%	64%	69%		63%
Percent of MMTh Goal	63%		37%	67%	63%

*LIEE = Low Income Energy Efficiency Programs
**Codes and Standards Savings from pre-2005 advocacy work

The Commission adopted cumulative goals starting in 2004 to encourage utilities to plan for long term savings and to make sure that savings that were not achieved in one cycle would be made up in the next cycle to continue to meet the cumulative goals. The Commission officially removed the savings for the 2004-2005 program cycle[71] from the cumulative savings targets for the 2010-2012 cycle, but it did not explicitly remove it from the 2006-2008 cumulative savings goals. Therefore, the comparison of 2004-2008 accomplishments and the cumulative goals are presented in Table 25.

[70] SDGE goals reflect updates in D. 09-09-047; September 24, 2009http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/107829.PDF

[71] Decision 09-05-037 http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/101543.PDF

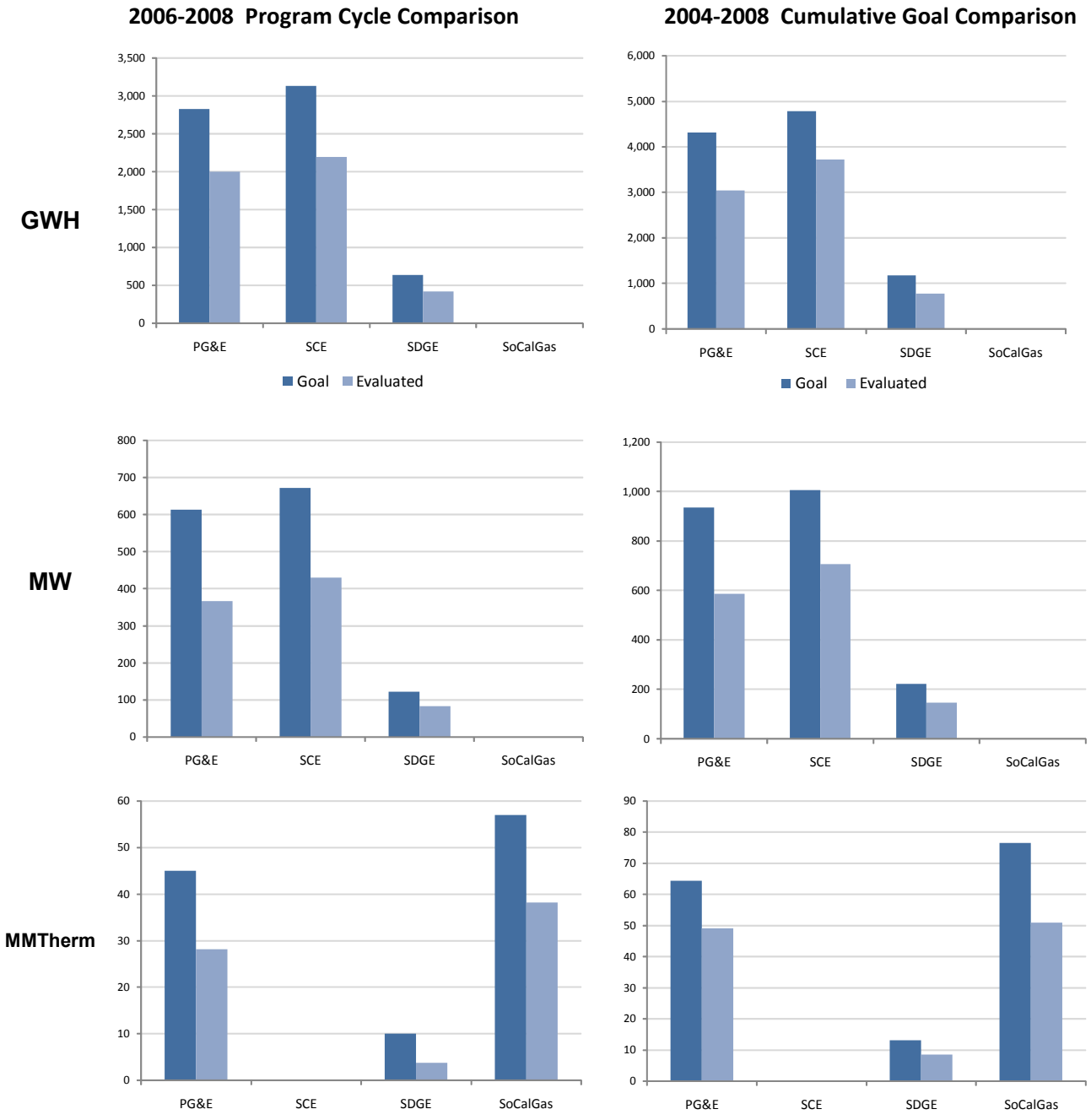
Table 25. Comparative of Cumulative 2004-2008 Evaluated Results to Goals

	PGE	SCE	SDGE	SoCalGas	Total
Savings Goals			**PY 2004-2008**		
Cumulative Savings (GWH)	4,313	4,788	1,175		10,488
Peak Savings (MW)	936	1,006	223		2,206
Cumulative Natural Gas Savings (MMTh)	64		13	77	154
EE Portfolio Savings (Reported)			**PY 2004-2008**		
Cumulative Savings (GWH)	6,993	6,195	1,483		14,670
Peak Savings (MW)	1,202	1,219	268		2,689
Cumulative Natural Gas Savings (MMTh)	111		10	93	214
EE Portfolio Savings (Evaluated)			**PY 2004-2008**		
Cumulative Savings (GWH)	2,764	3,461	707		6,931
Peak Savings (MW)	532	655	132		1,318
Cumulative Natural Gas Savings (MMTh)	41		7	43	92
50% C&S Savings (Evaluated)			**PY 2006-2008**		
Cumulative Savings (GWH)	157	162	37		356
Peak Savings (MW)	30	31	7		68
Cumulative Natural Gas Savings (MMTh)	2		0	3	6
EM&V Adjusted LIEE Savings			**PY 2004-2008**		
Cumulative Savings (GWH)	124	107	28		258
Peak Savings (MW)	25	22	7		54
Cumulative Natural Gas Savings (MMTh)	6		1	5	12
Performance against 2004-2008 Cumulative Goals					
Percent of GWH Goal	71%	78%	66%		72%
Percent of MW Goal	63%	70%	65%		65%
Percent of MMTh Goal	76%		66%	67%	71%

Combined, the utilities achieved roughly 72 percent of the statewide electric goals, and 65 and 71 percent of the MW and MM therm goals respectively in the 2004-2008 program implementation period. The increase in the therm savings relative to the goal reflects the dual effects of a reduced therm goal for PGE and SDGE and the fact that negative therm interactive effects were not included in the 2004-2005 evaluation studies.

The charts within **Figure 41. Comparison of Evaluated Savings against the Commission Adopted Goals** show the relative accomplishment of energy savings against both the 2004-2008 and 2006-2008 goals.

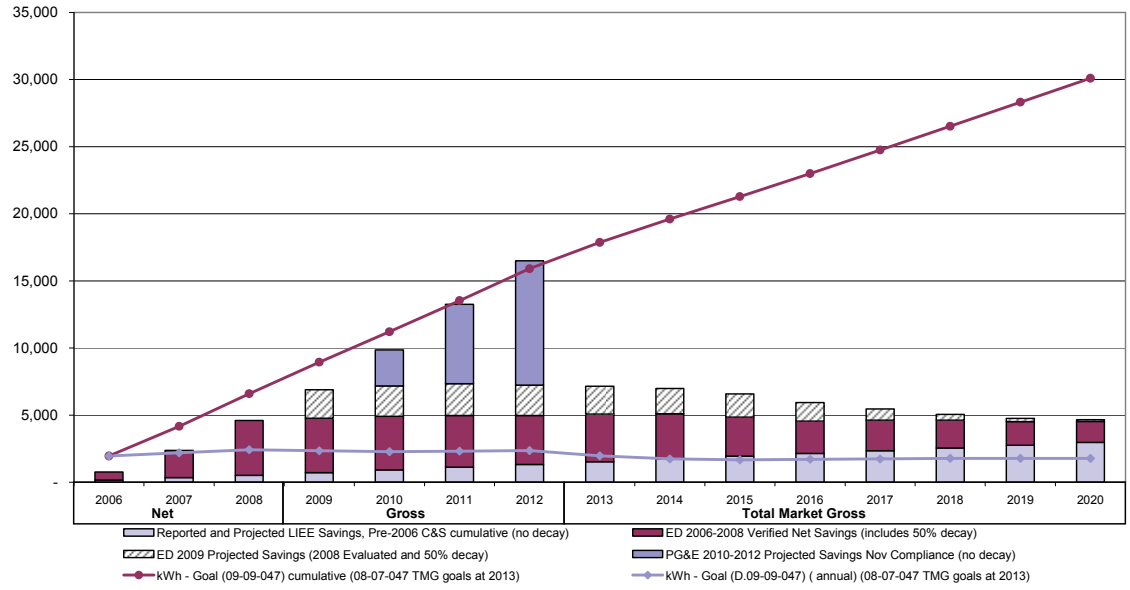
Figure 41. Comparison of Evaluated Savings against the Commission Adopted Goals



The goals for the 2006-2008 period represent the first portion of the Commissions long-term energy efficiency goals.[72] The goals were formulated based on studies of the technical and economic potential of energy efficiency technologies. The goals in place for any given year (maroon line in Figure 42) reflect Commission decisions since 2004 to adopt and modify the goals based on new information. A summary of these decisions and the resulting goals is presented in Appendix P History of California Public Utility Commission Goals for Energy Efficiency. The maroon boxes represent the savings that were achieved in 2006-2008 and the lasting impact of these measures through 2020. The striped box represents an estimate of the savings expected from efficiency programs in place in 2009 and the lasting impact of these measures through 2020. The blue boxes that appear in 2010 represent the projected savings for the 2010, 2011, and 2012 program years, but the lasting impact from these measures are not included. Programs have not yet been designed for the period from 2013-2020, but their design will be guided by the California Strategic Plan to acquire the incremental energy savings required to meet the goals.

The projected savings for the 2010-2012 program cycle, which have not fully incorporated the evaluation results presented in the 2006-2008 evaluation reports, in combination with the achievements in the 2006-2008 program cycle may be sufficient to meet electric and natural gas savings goals by the end of the 2012 cycle. The peak goal is not projected to be achieved by the end of 2012 based on these assumptions.

Figure 42. All IOU Electric Savings Accomplishments and Projections v. Long Term Goals



[72] The first goals decision applicable to this program implementation period was D. 04-09-060; September 23, 2004 [http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/40212.pdf] The original goals decision established goals for 2004-2013 based on the Secret Surplus potential study. In addition a Statewide Goals Study prepared by CEC staff was used identify achievable potential and establish the adopted goals.

Figure 43. All IOU Peak Savings Accomplishments and Projections v. Long Term Goals

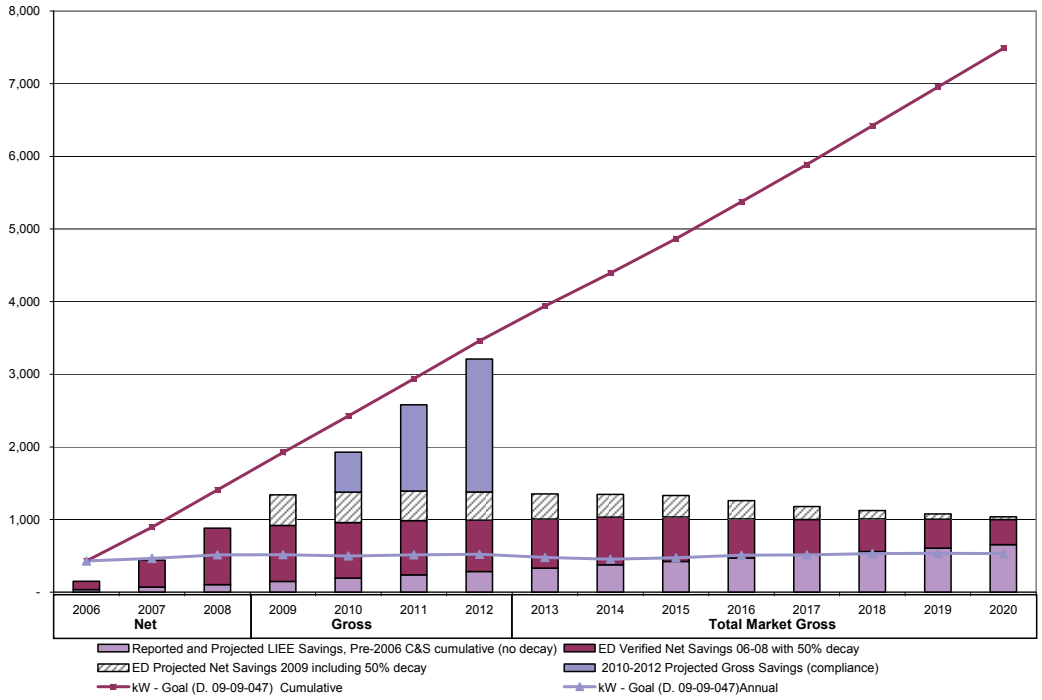
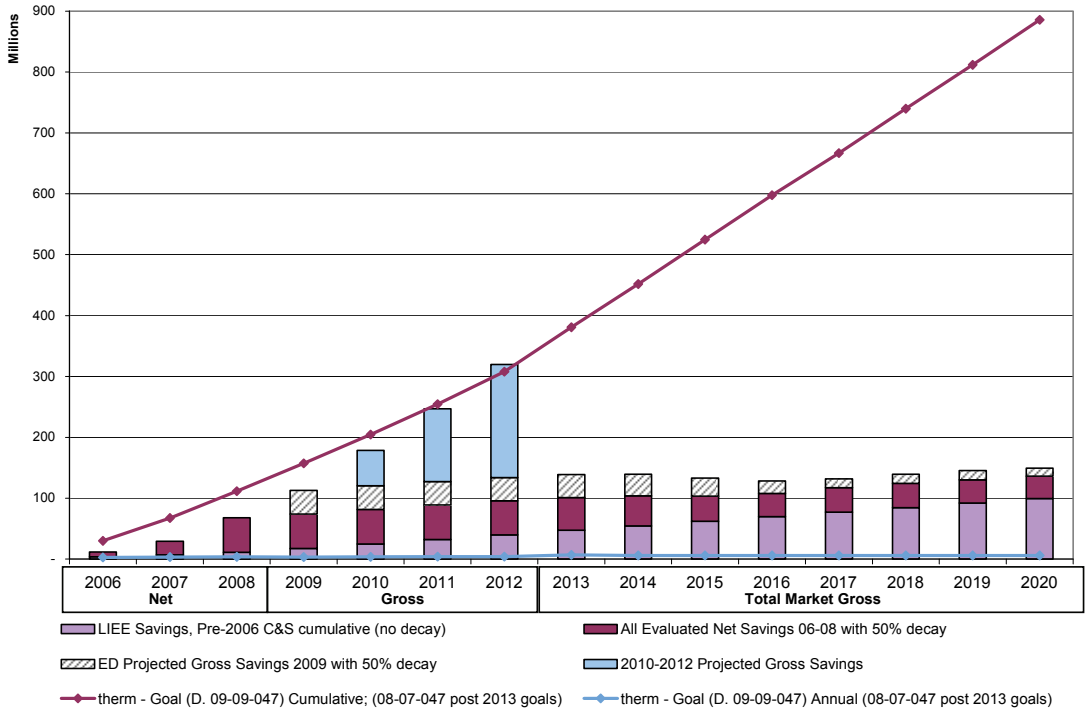


Figure 44. All IOU Natural Gas Savings Accomplishments and Projections v. Long Term Goals



4.6. Comparative Interactive Effects in Evaluated Savings

One notable difference in the natural gas savings accomplishments relative to the goals can be explained by the inclusion of negative therm interactive effects. Interactive effects have long been considered and measured in savings estimates and evaluation when looking at whole building or process measures. They are also present for individual measures. Interactive effects that are included in the evaluated results are specific to heating ventilation and cooling systems. The interior building load reduction/increase due to a measure installation in a facility can interact with the heating, ventilating and air-conditioning (HVAC) system, resulting in changes in the consumption of electricity or gas. These HVAC interactive effects can result in positive or negative changes in consumption, and can cross fuel types and energy/demand categories.

In the 2006-2008 program cycle the prominence of the compact fluorescent bulbs in the portfolio magnify these effects in the residential sector, leading to notable negative savings. While no empirical studies were conducted in this cycle of evaluation, the interactive effects factors that have been adopted for DEER were applied for most lighting measures in the portfolio. These are included in the net and gross evaluated savings results presented throughout this report.

The net energy savings both including and not including all interactive effects (positive and negative) are presented in the following table.

The comparison of the interactive effects in Table 26 only includes the interactive effects that are based on DEER updates and the most recent corrections and revisions to the interactive effects factors (see Appendix B for an explanation of the method used to calculate these values). For evaluations that included a process or other measurement and verification plan that considered all positive and negative interactive effects, the savings are the same in either scenario. As shown in Table 26, the impacts are primarily on the natural gas savings and largely due to the concentration of savings in efficient indoor lighting technologies and refrigeration savings. Note that the influence on electric savings are small and negative when interactive effects are not included -- only about 3% for GWh, and 11% for MW – while the difference for therms is notable -- a 38% increase in savings when interactive effects are not included.

Table 26. Comparison of Evaluated Savings with and without interactive effects

		NET With Interactive Effects			Net Without Interactive Effects		
	Market Segment	**GWh**	**MW**	**MMTherms**	**GWh**	**MW**	**MMTherms**
PGE	Residential	37%	32%	-38%	37%	28%	8%
	Industrial	7%	5%	33%	7%	5%	21%
	Commercial	49%	57%	71%	48%	59%	50%
	Agricultural	7%	7%	34%	7%	7%	22%
		1,766	**320**	**22**	**1,753**	**296**	**35**
SCE	Residential	41%	37%	90%	40%	35%	20%
	Industrial	17%	13%	2%	17%	14%	13%
	Commercial	38%	45%	8%	40%	46%	67%
	Agricultural	3%	4%	0%	3%	5%	0%
		1,963	**384**	**-13**	**1,871**	**340**	**0**
SCG	Residential	80%	96%	11%	70%	93%	11%
	Commercial	20%	4%	89%	30%	7%	89%
		4	**3**	**32**	**5**	**3**	**32**
SDGE	Residential	28%	28%	9%	29%	28%	35%
	Industrial	0%	0%	8%	0%	0%	5%
	Commercial	72%	72%	76%	71%	72%	55%
	Agricultural	0%	0%	7%	0%	0%	5%
		364	**72**	**3**	**349**	**64**	**4**
	Residential Sum	38%	35%	-38%	38%	32%	11%
	Industrial Sum	11%	9%	17%	11%	9%	11%
	Commercial Sum	46%	52%	104%	46%	54%	68%
	Agricultural Sum	4%	5%	18%	5%	5%	11%
Grand Total		**4,097**	**779**	**44**	**3,978**	**702**	**71**

4.7. IOU Energy Efficiency Portfolio Results

4.7.1. 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 45. PGE Electric Savings by Market Distribution and Technology Type

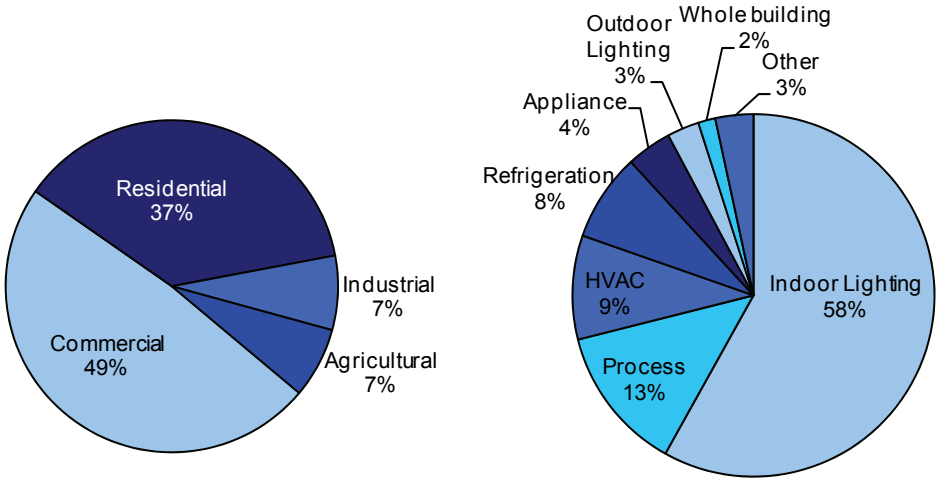


Figure 46. PGE Natural Gas Savings by Market Distribution and Technology Type

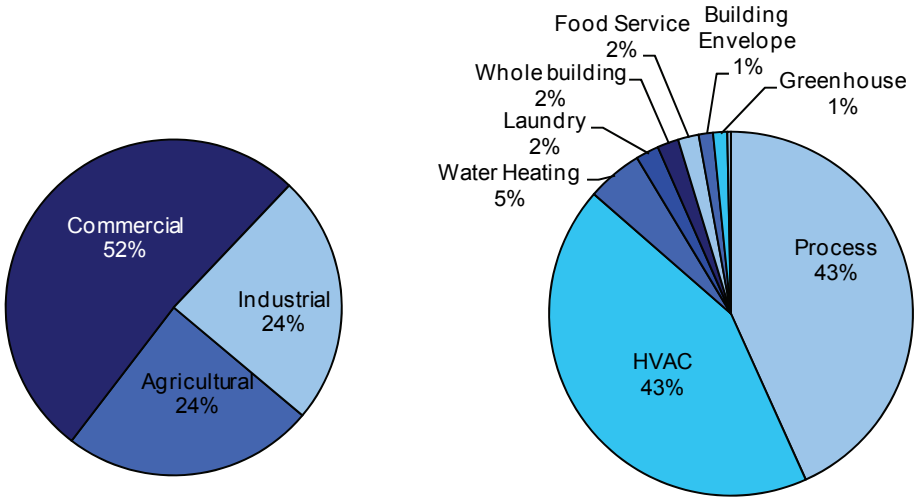


Table 27. PGE Savings Impacts

2006-2008	Annual Impacts		Lifecycle Impact		% of 2008 sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
GWh	6,292	5,251	57,486	46,603	7%
MW	994	845			
MMTherm	83	66	1,404	1,091	3%
Evaluated Savings					
GWh	2,999	1,766	30,315	18,537	3%
MW	513	320			
MMTherm	47	22	918	411	2%
2006-2008 Program Cycle Goal					
GWh		2,826			3%
MW		613	*No lifecycle goals*		
MMTherm		45			2%
Emissions Reductions					
Tons of CO_2 Avoided	1,909,936	1,201,013	21,914,044	10,368,241	

Figure 47. PGE Electric Savings Accomplishments and Projections v. Long Term Goals

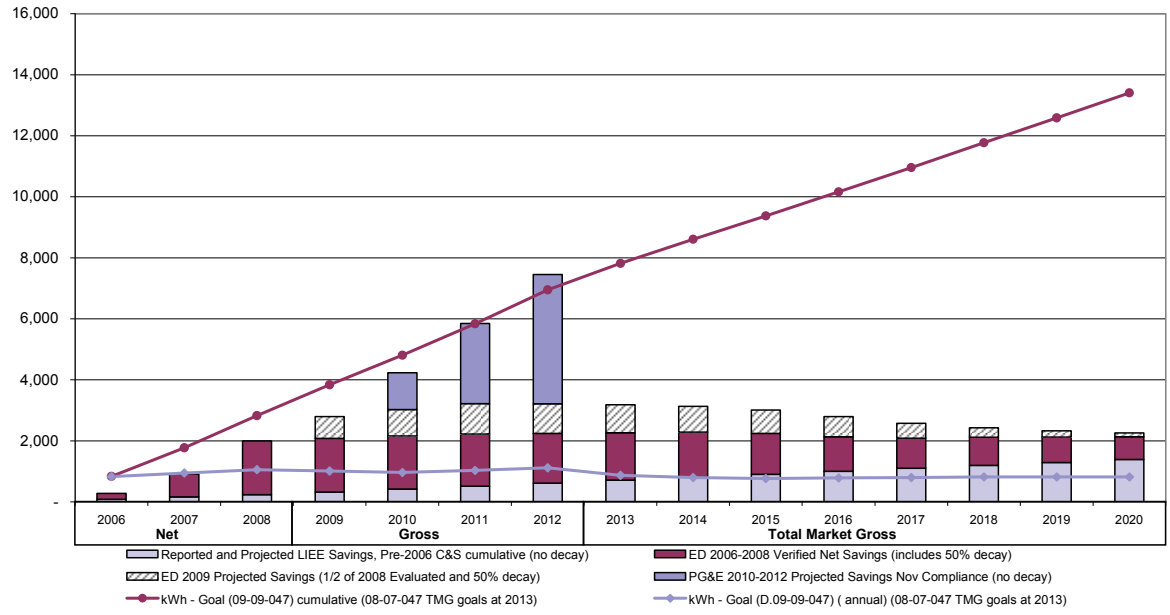


Figure 48. PGE Peak Savings Accomplishments and Projections v. Long Term Goals

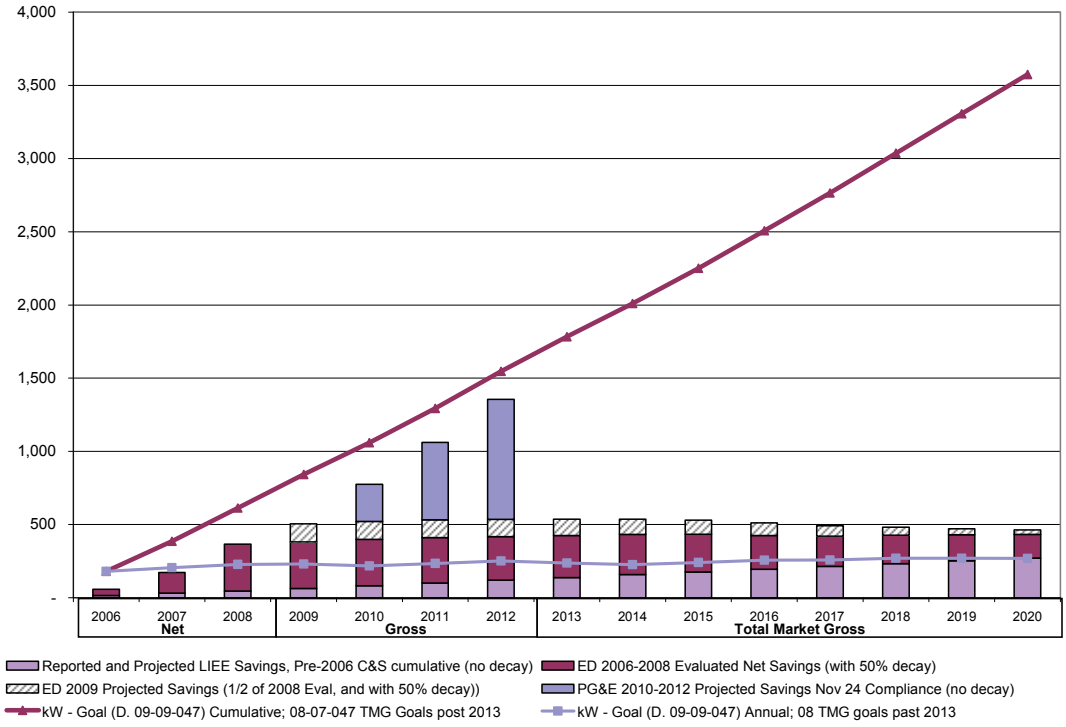
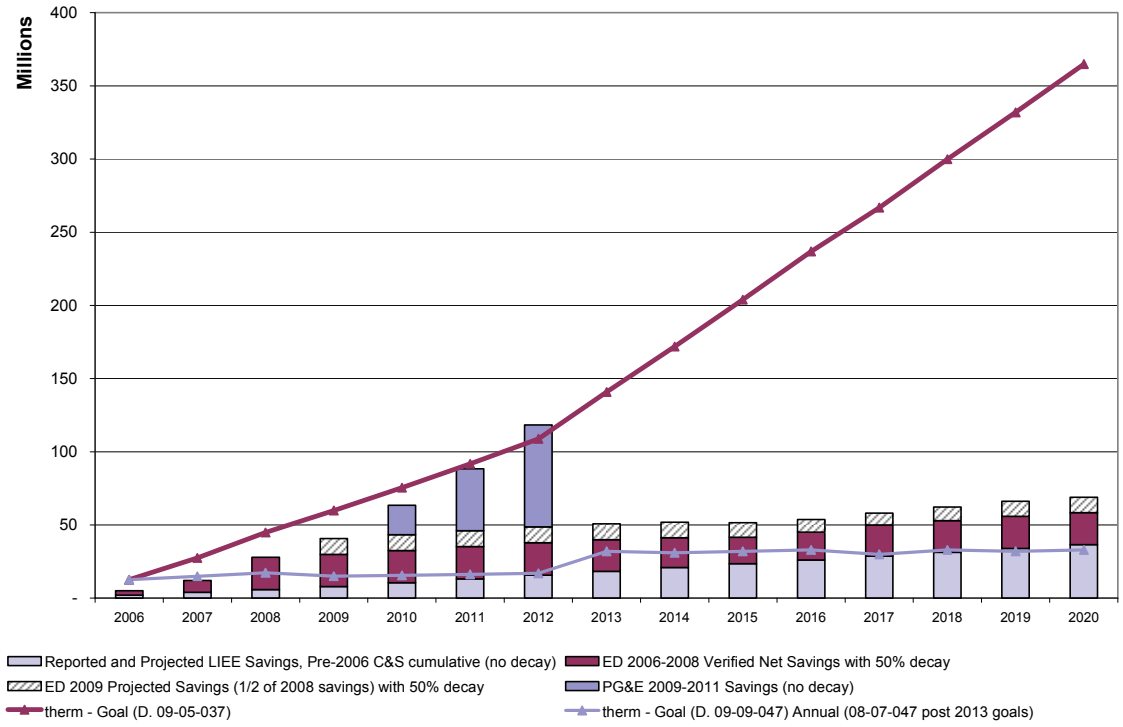


Figure 49. PGE Natural Gas Savings Accomplishments and Projections v. Long Term Goals



4.7.2. 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 50. SCE Savings by Market Distribution and Technology Type

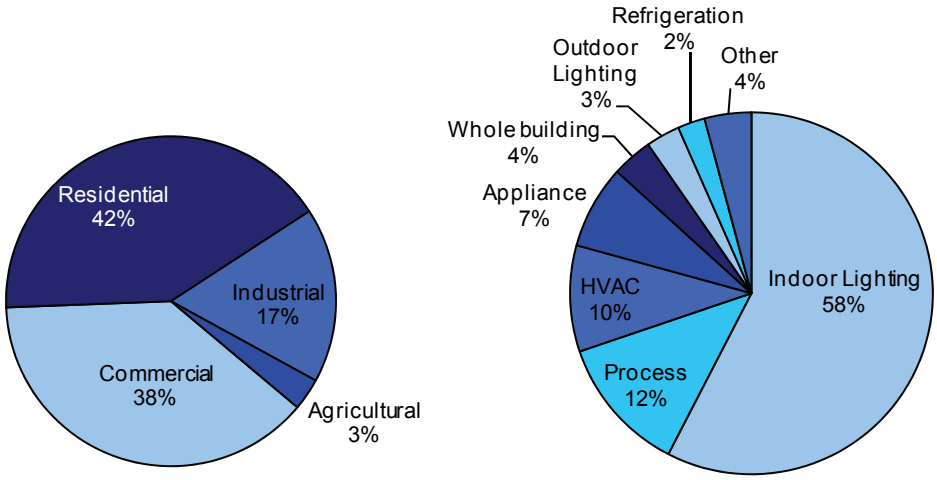


Table 28. SCE Savings Impacts

2006-2008	Annual Impacts		Lifecycle Impact		% of 2008 sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
GWh	5,100	3,898	46,769	35,506	5%
MW	885	690			
Evaluated Savings					
GWh	2,936	1,963	29,719	20,029	3%
MW	551	383			
2006-2008 Program Cycle Goal					
GWh		3,135	*No Lifecycle Goals*		3%
MW		672			
Emissions					
Tons of CO_2 Avoided	1,553,567	1,046,414	15,992,515	11,372,622	

Figure 51. SCE Electric Savings Accomplishments and Projections v. Long Term Goals

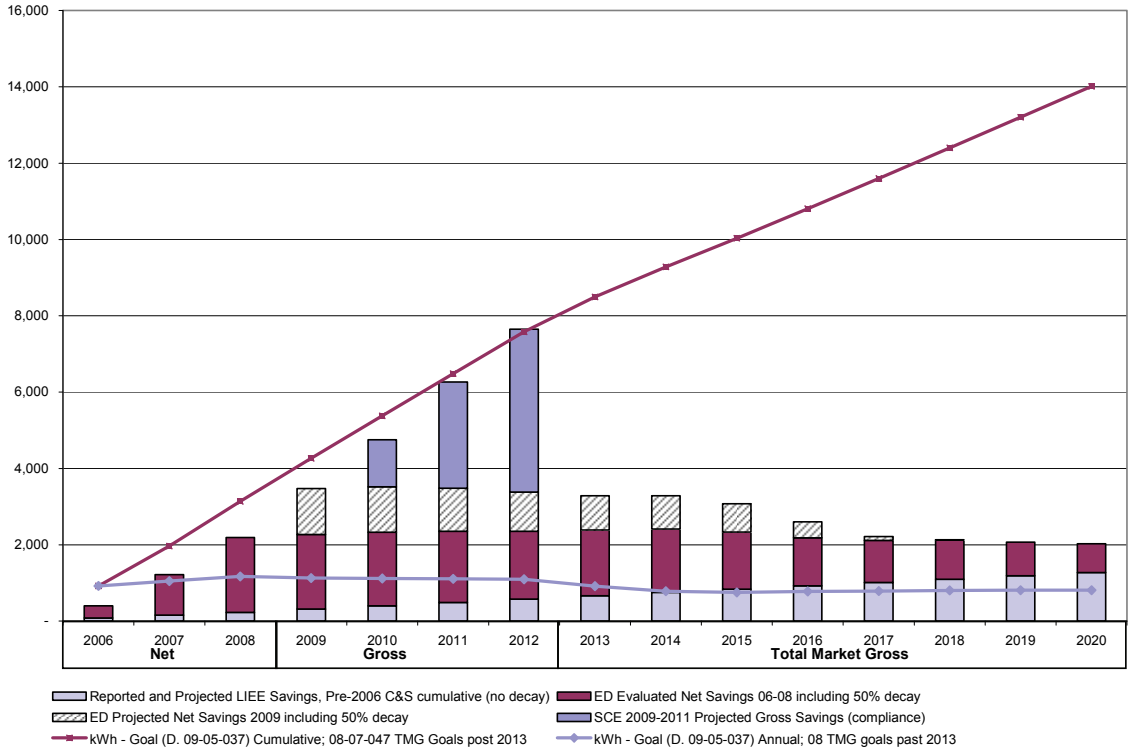
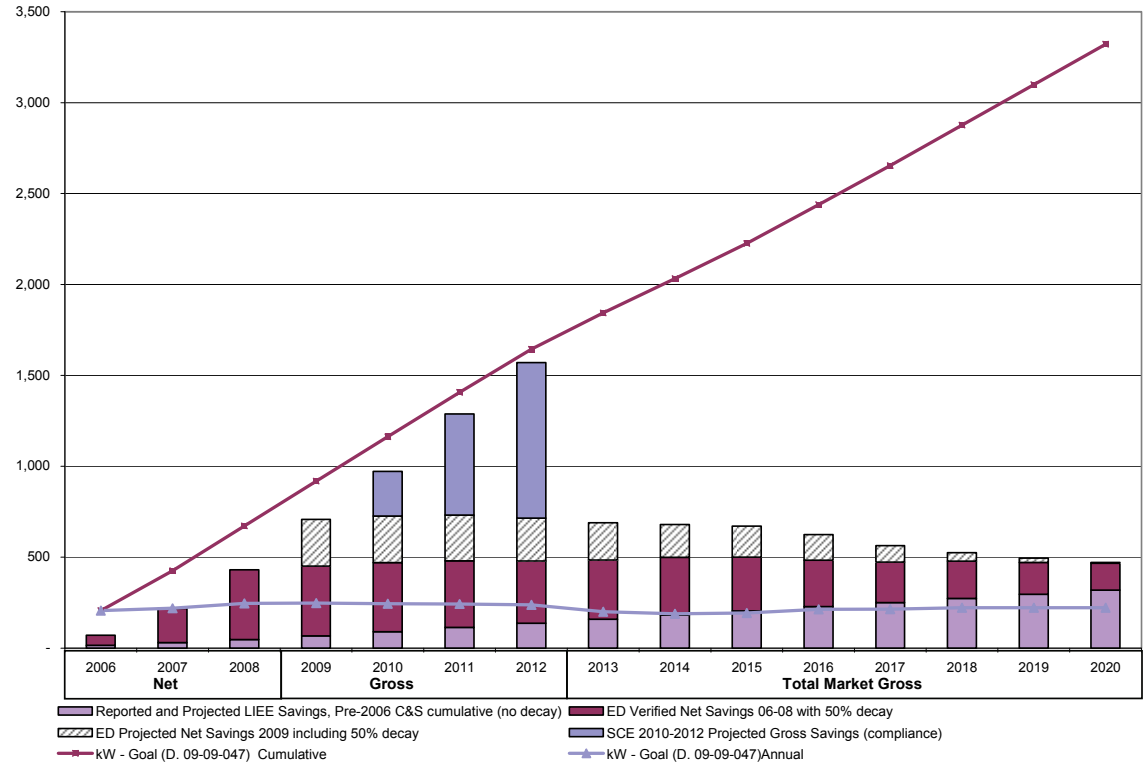


Figure 52. SCE Peak Savings Accomplishments and Projections v. Long Term Goals]



4.7.3. 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 53. SDGE Electric Savings by Market Distribution and Technology Type

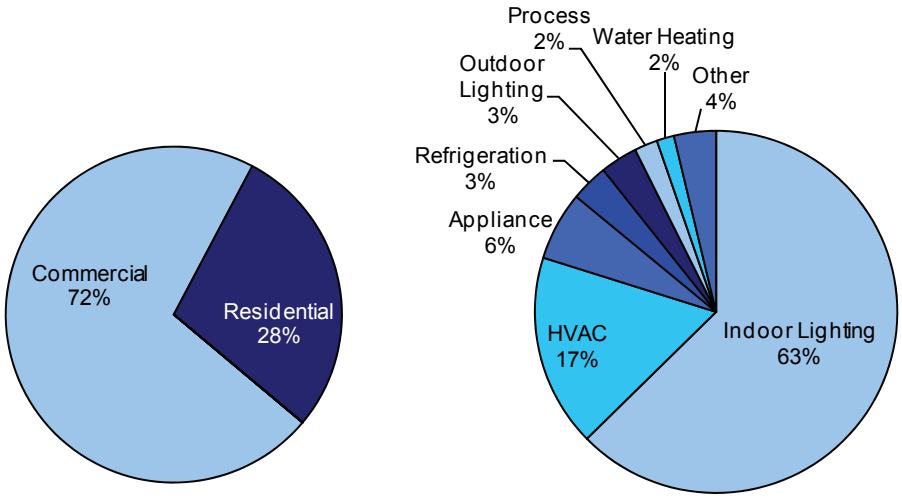


Figure 54. SDGE Natural Gas Savings by Market Distribution and Technology Type

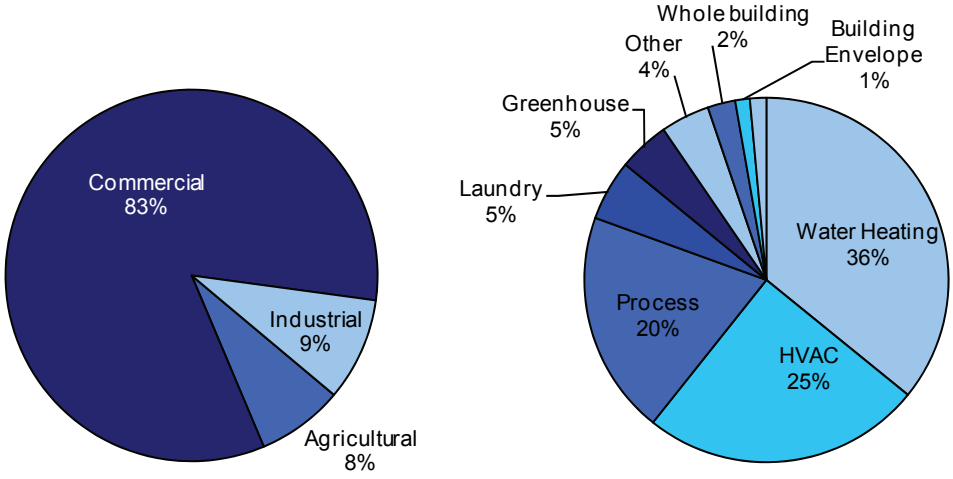


Table 29. SDGE Savings Impacts

2006-2008	Annual Impacts		Lifecycle Impact		% of 2008 sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
GWh	1,035	850	10,418	8,494	8%
MW	175	147			
MMTherm	8	7	103	86	1.1%
Evaluated Savings					
GWh	554	364	5,967	4,100	4%
MW	106	72			
MMTherm	3	3	51	37	0.46%
2006-2008 Program Cycle Goal					
GWh		638			5%
MW		122	*No lifecycle goals*		
MMTherm		10			1.4%
Emissions					
Tons of CO_2 Avoided	333,325	222,786	3,676,759	2,343,154	

Figure 55. SDGE Electric Savings Accomplishments and Projections v. Long Term Goals

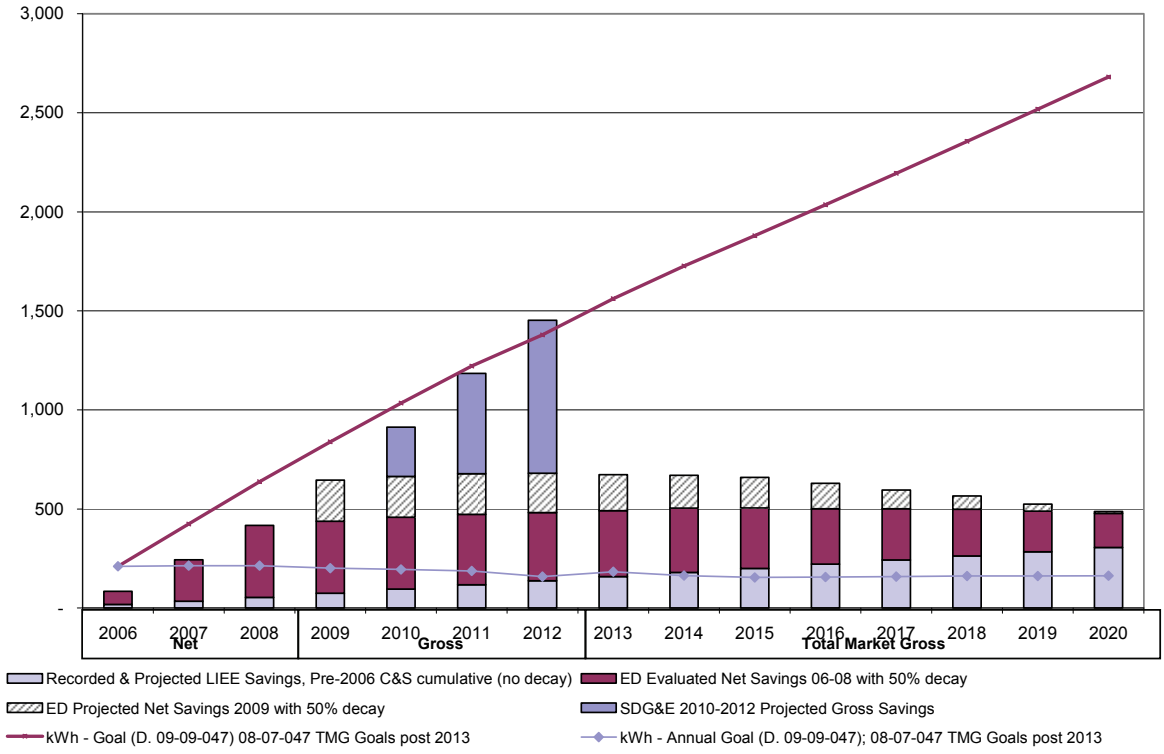


Figure 56. SDGE Peak Savings Accomplishments and Projections v. Long Term Goals

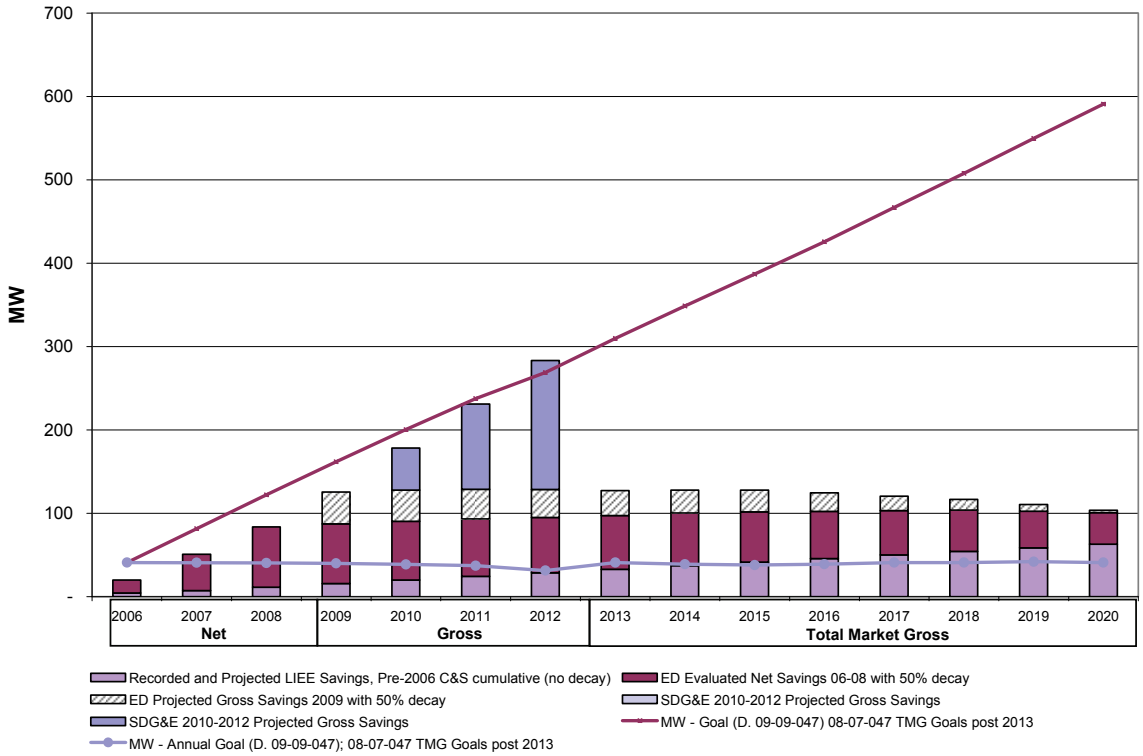
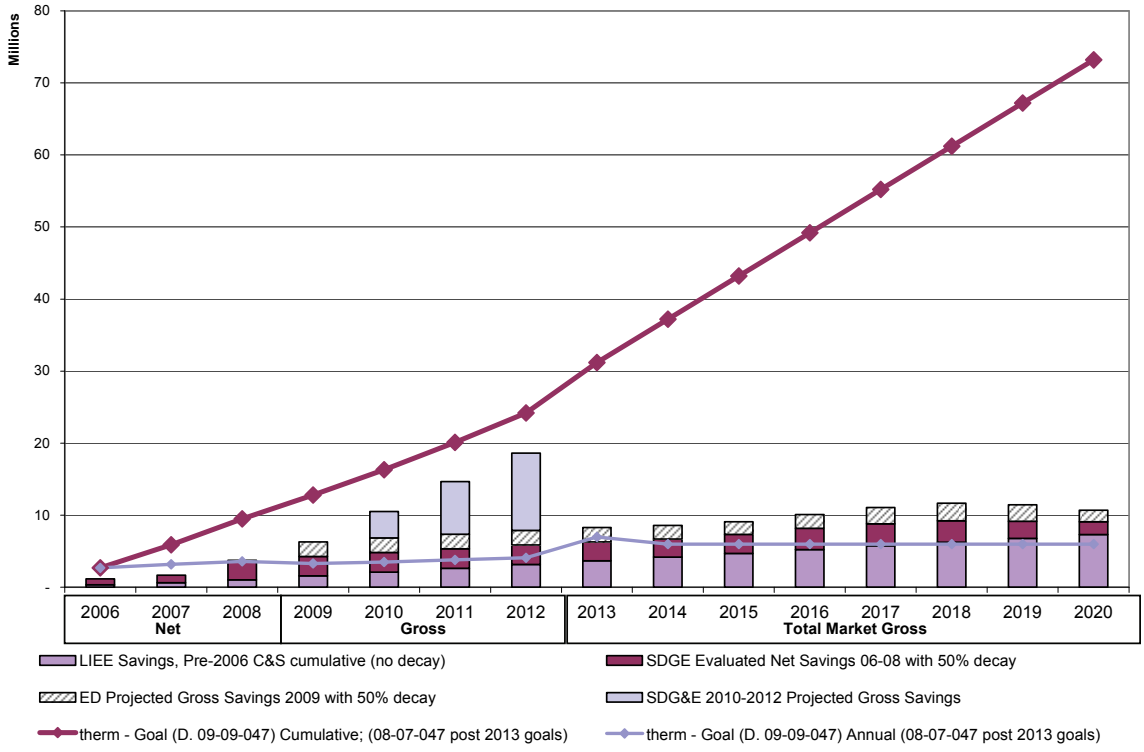


Figure 57. SDGE Natural Gas Savings Accomplishments and Projections v. Long Term Goals



4.7.4. 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 58. SCG Natural Gas Savings by Market Distribution and Technology Type

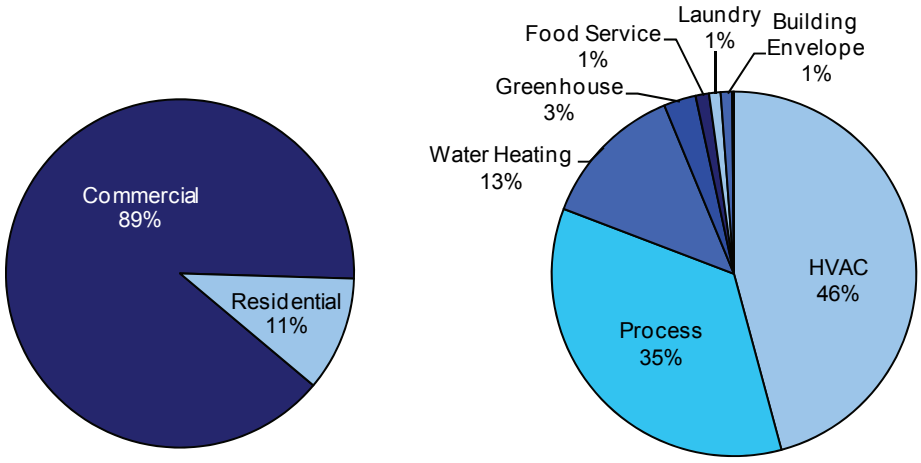
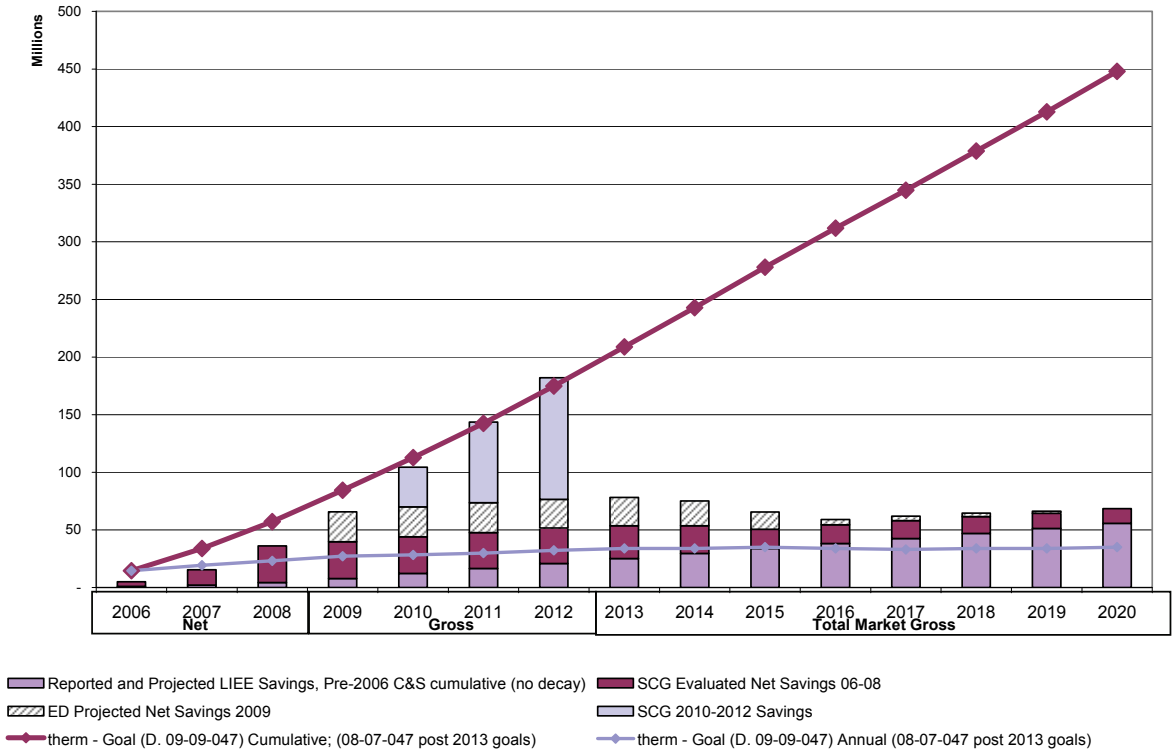


Table 30. SCG Savings Impacts

2006-2008	Annual Impacts		Lifecycle Impact		% 2008 sales
	Gross	Net	Gross	Net	Gross
Reported Savings					
MMTherm	75	67	1,094	975	1.4%
Evaluated Savings					
MMTherm	54	32	574	344	1.0%
2006-2008 Program Cycle Goal					
MMTherm		57	*No Lifecycle Goals*		1.1%
Emissions					
Tons of CO_2 Avoided	319,344	171,916	3,438,345	207,558	

Figure 59. SCG Natural Gas Savings Accomplishments and Projections v. Long Term Goals



5. LIFECYCLE SAVINGS IMPACTS

The impacts from the 2006-2008 program cycle will have lasting effects for several years to come. The potential for long term impacts from any given program cycle is dependent on the investments in measures that offer long term savings. The estimated savings in each year through 2028 are presented by market sector to illustrate these impacts by market sector.

Lifecycle savings impacts from the 2006-2008 energy efficiency programs are modeled based on the energy savings estimates made available during the program cycle and multiplied by the expected useful lives of the installed technologies. The sum of the lifecycle savings by IOU are presented in the previous section. The estimates of lifecycle savings impacts, however, are not a comprehensive picture of the expected savings over time, as energy savings technologies installed during the 2006-2008 program cycle may be affected by changes in economic activity (affecting production rates) and/or early expiration of technologies due to either remodeling or technology failures. Evaluators base energy savings on actual observed post-installation conditions not conditions re-normalized to represent future unobserved economic conditions. These estimates also do not take into consideration the potential for declining savings from aged equipment. Nevertheless, the estimates present the long-term potential impacts of the specific measures installed in 2006-2008. No consideration of the long term influence of the programs on market factors is included.

The savings that are first achieved in 2006-2008 and persist from one year to the next over the lifecycle are presented in the graphics in this section. The intent is to illustrate how the installed measures will likely expire in the future and how this effect is different for each market sector. Figure 60 presents the lifecycle savings from the 2006-2008 program cycle. The savings that persist from the 2004-2005 program cycle are not included in this graphic, nor are savings projected for future energy efficiency programs.

Figure 60. Lifecycle Stream of Electric Savings through 2028

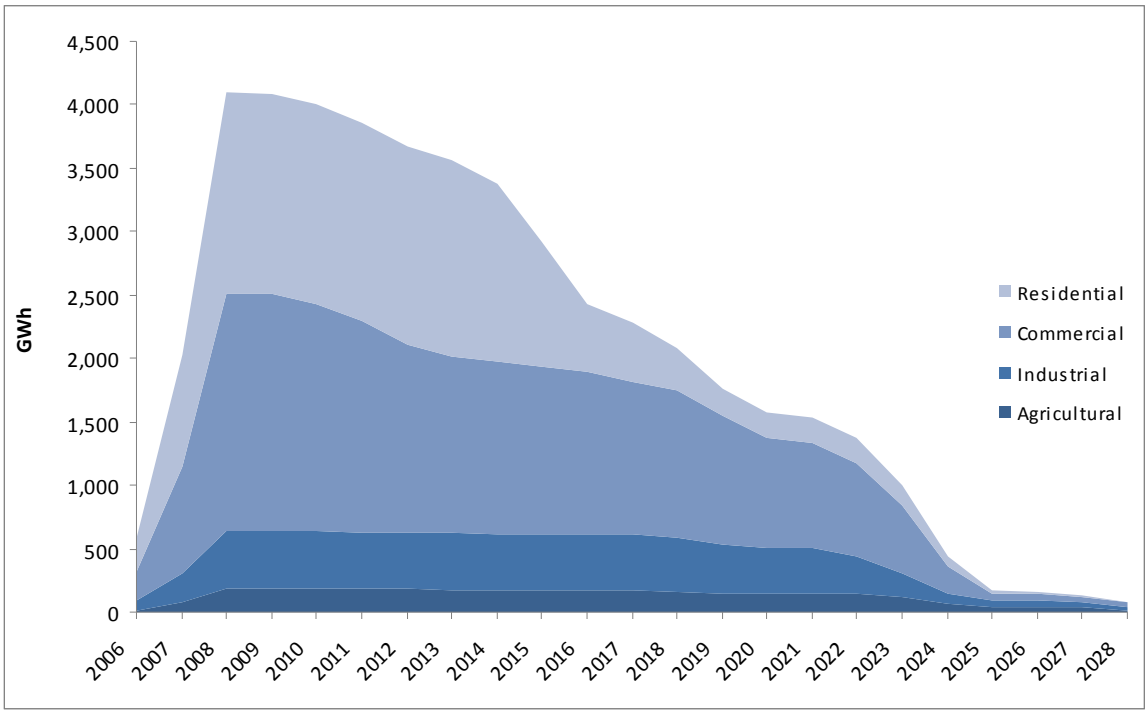
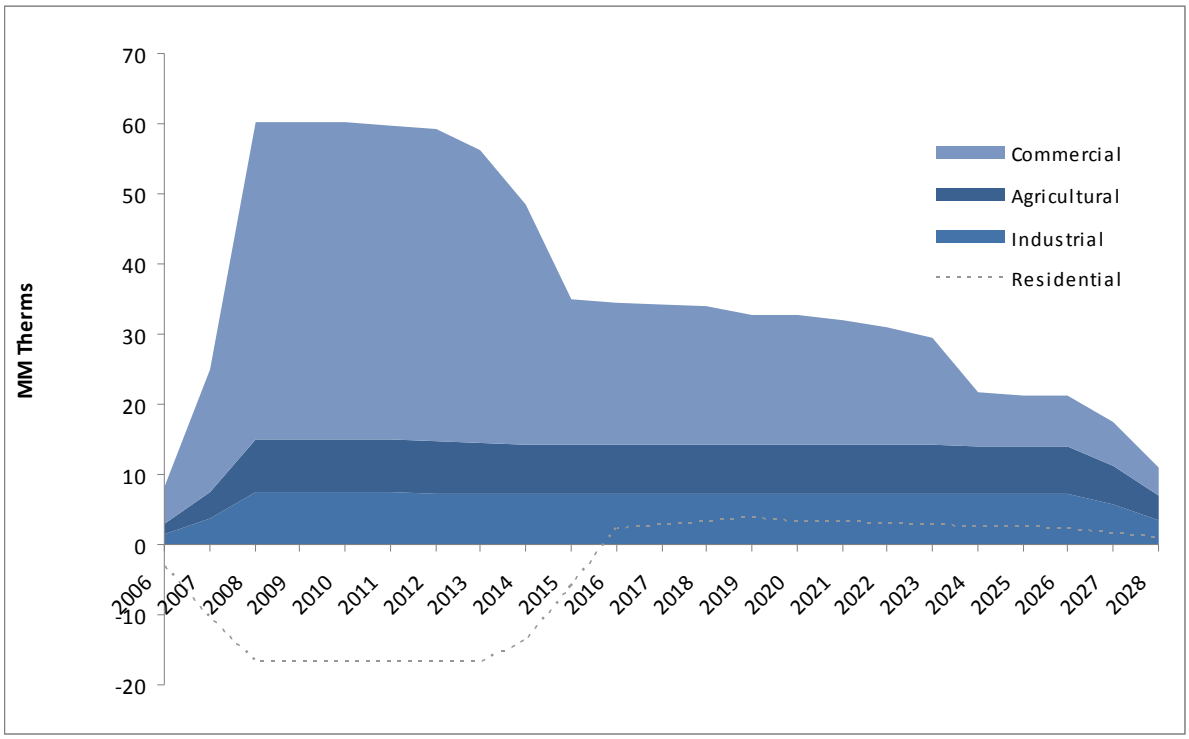


Figure 61. Lifecycle Stream of Natural Gas Savings through 2028



IOU specific graphics can be found at the end of this section.

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 some expected useful lives of only two- to three-years, causing a significant drop in savings after 2010. Longer-term savings were attributable to measures that are built in, such as insulation and fixtures. Overall, technologies that deliver natural gas savings have greater longevity.

The observed decrease in energy savings over time is referred to as "measure savings decay." Commission policy dictates that the IOUs must make up technology savings decay in any given year to comply with the established goals. In any given year the IOU(s) must make up for the shortfall in the preceding program cycle and recover the technology decay from any prior cycle in order to meet the cumulative savings goal for that given year. Because energy savings from the 2004-2005 program cycle will not be used for cumulative goals in the 2009-2012 time period, the savings from that period are not included.

It is important to note that the impact evaluations do not generally incorporate estimation of the potential long term market effects of the energy efficiency programs, either prospectively or retrospectively. 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 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.

The natural gas savings show an increase in natural gas savings that corresponds with the expiration of lighting measures that cause negative HVAC interactive effects. Since no long term adoption or replacement of the lighting and appliance technologies is modeled, the savings from natural gas measures with greater longevity re-appear in the graphic around 2016.

Lifecycle savings impacts are provided for each utility in the following figures.

Figure 62. PGE Lifecycle Stream of Electric Savings through 2028

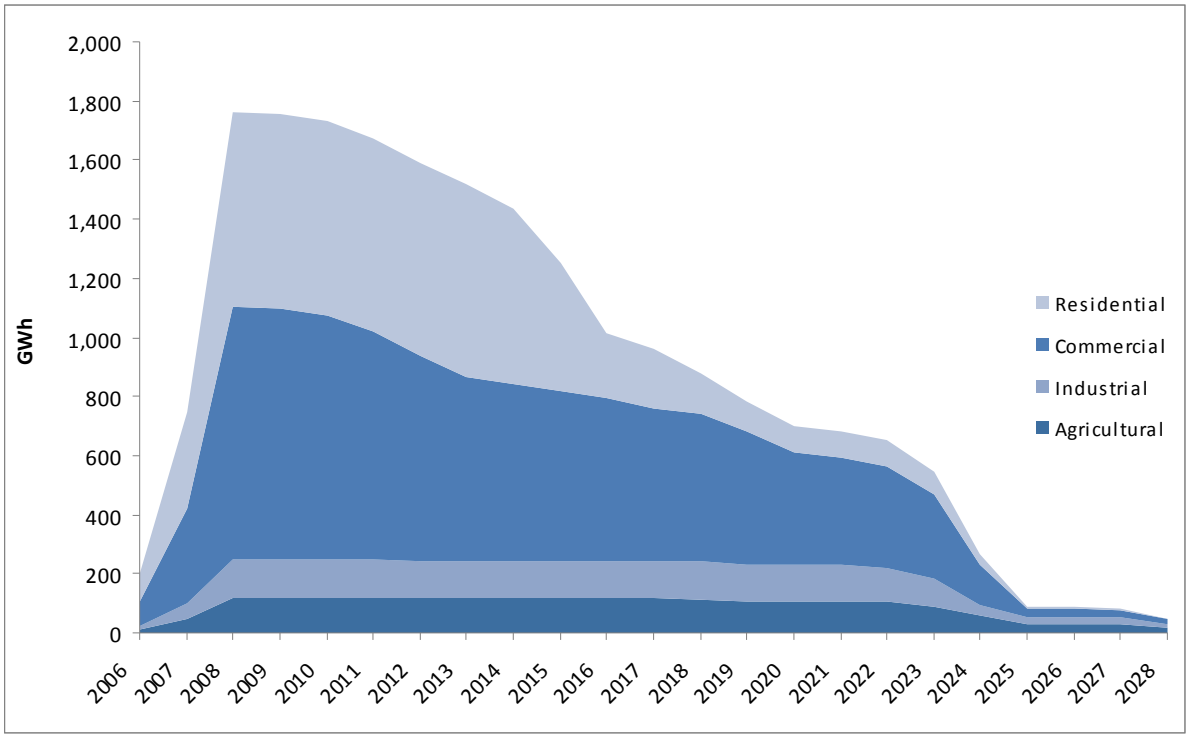


Figure 63. PGE Lifecycle Stream of Natural Gas Savings through 2028

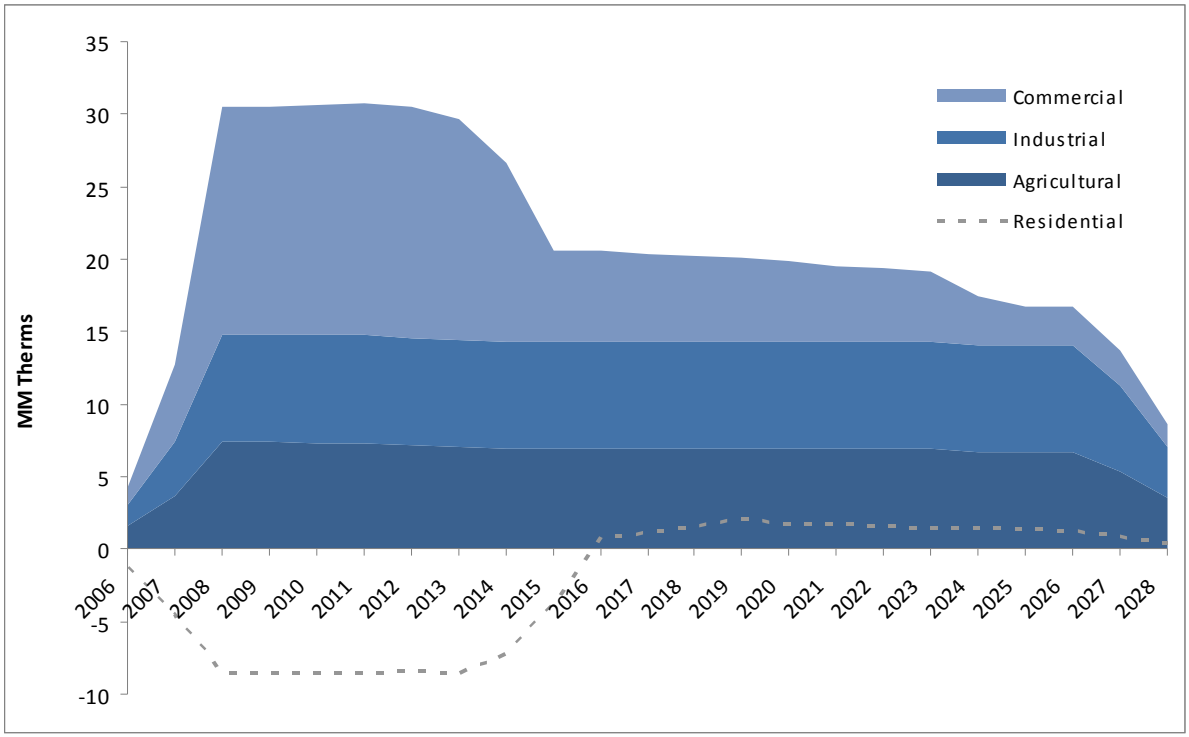


Figure 64. SCG Lifecycle Stream of Natural Gas Savings through 2028

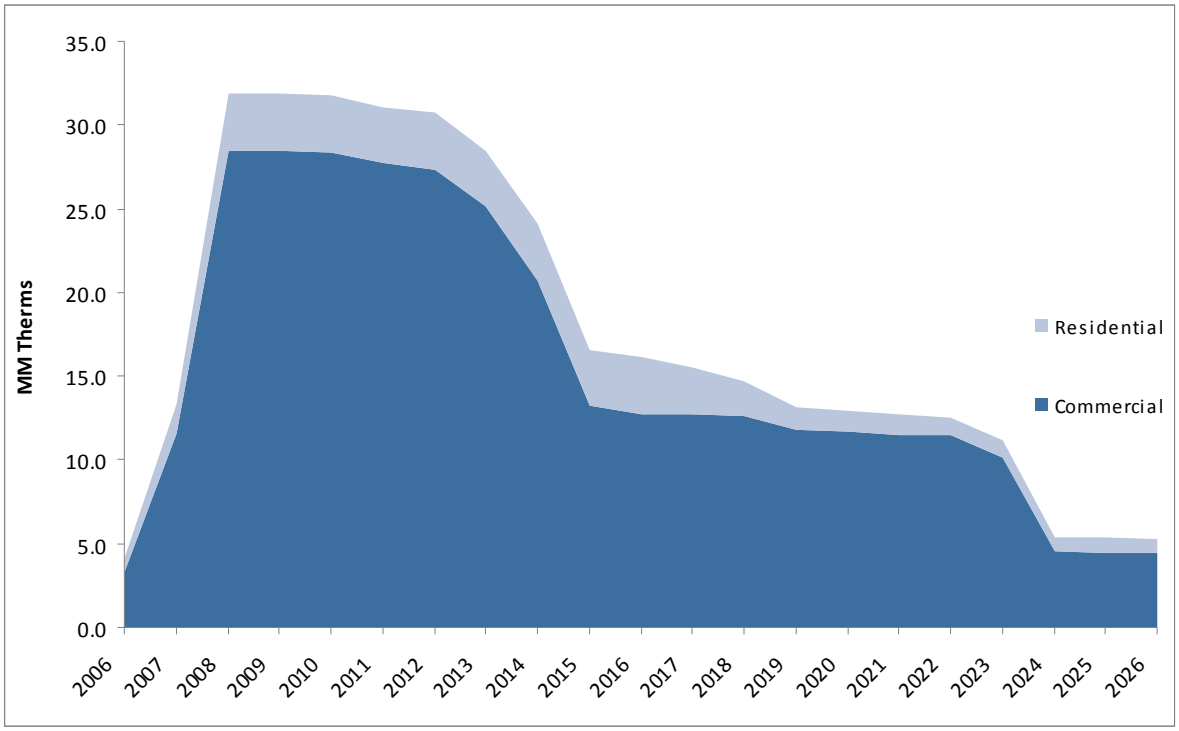


Figure 65. SCE Lifecycle Stream of Electric Savings through 2028

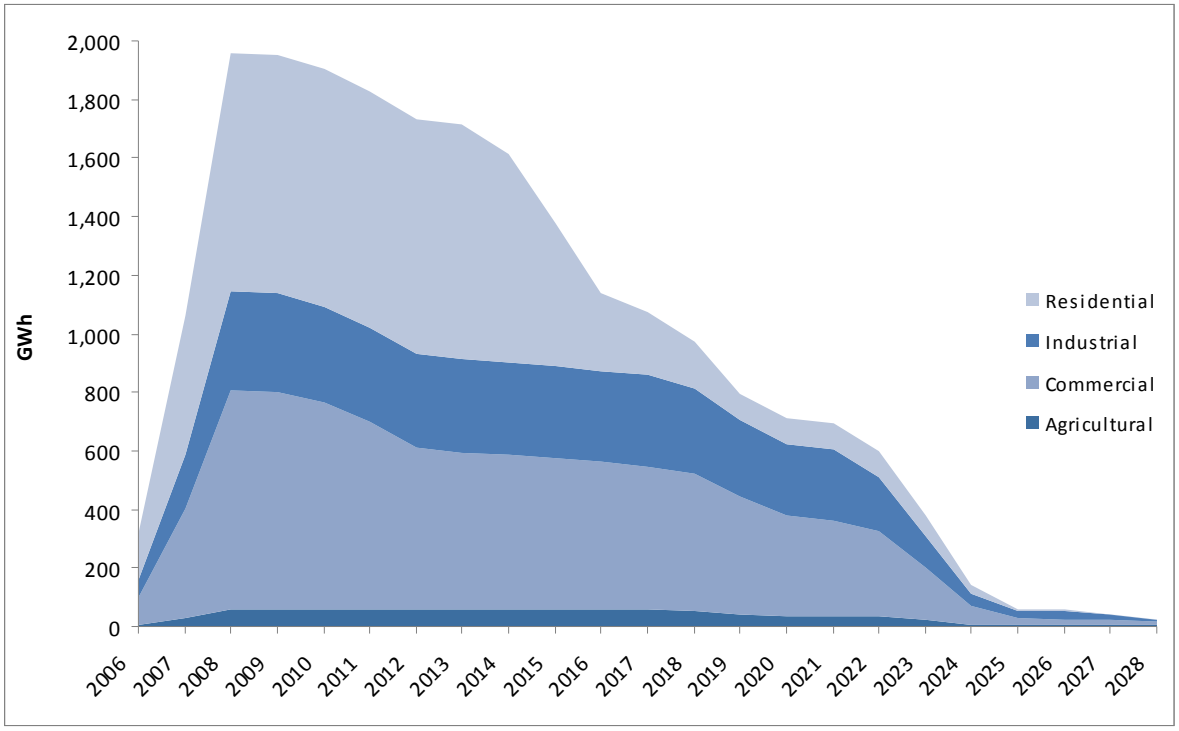


Figure 66. SDGE Lifecycle Stream of Electric Savings through 2028

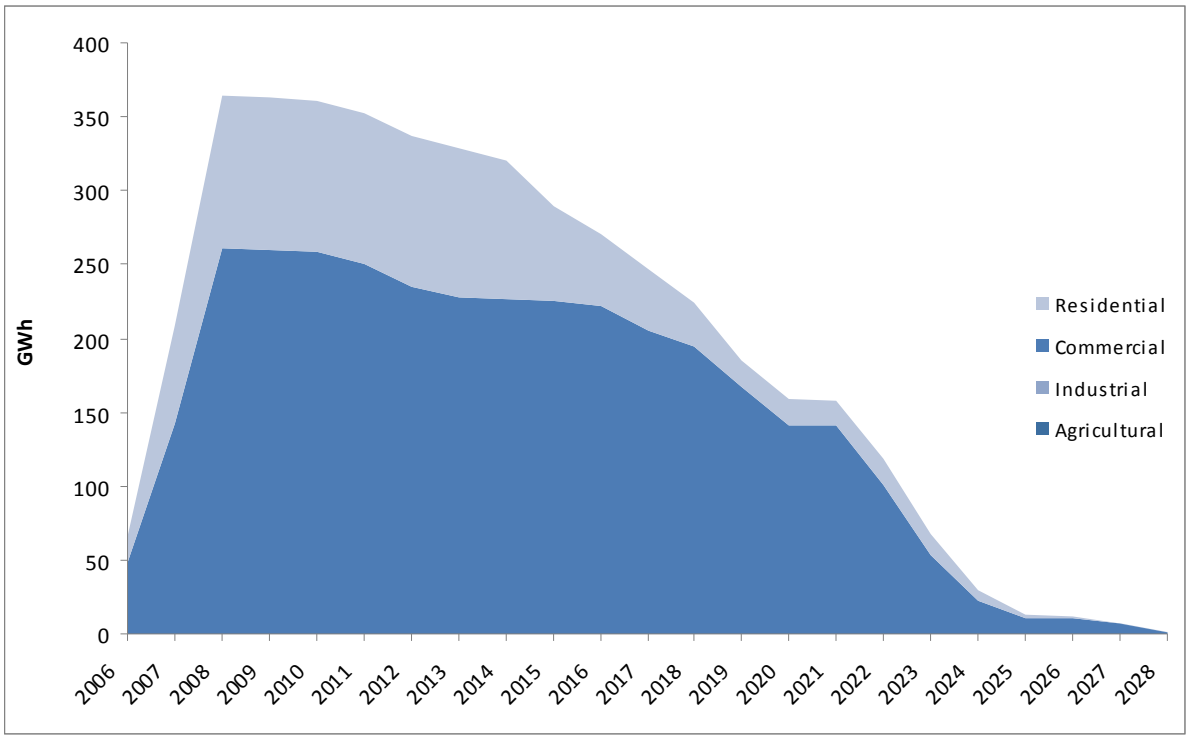
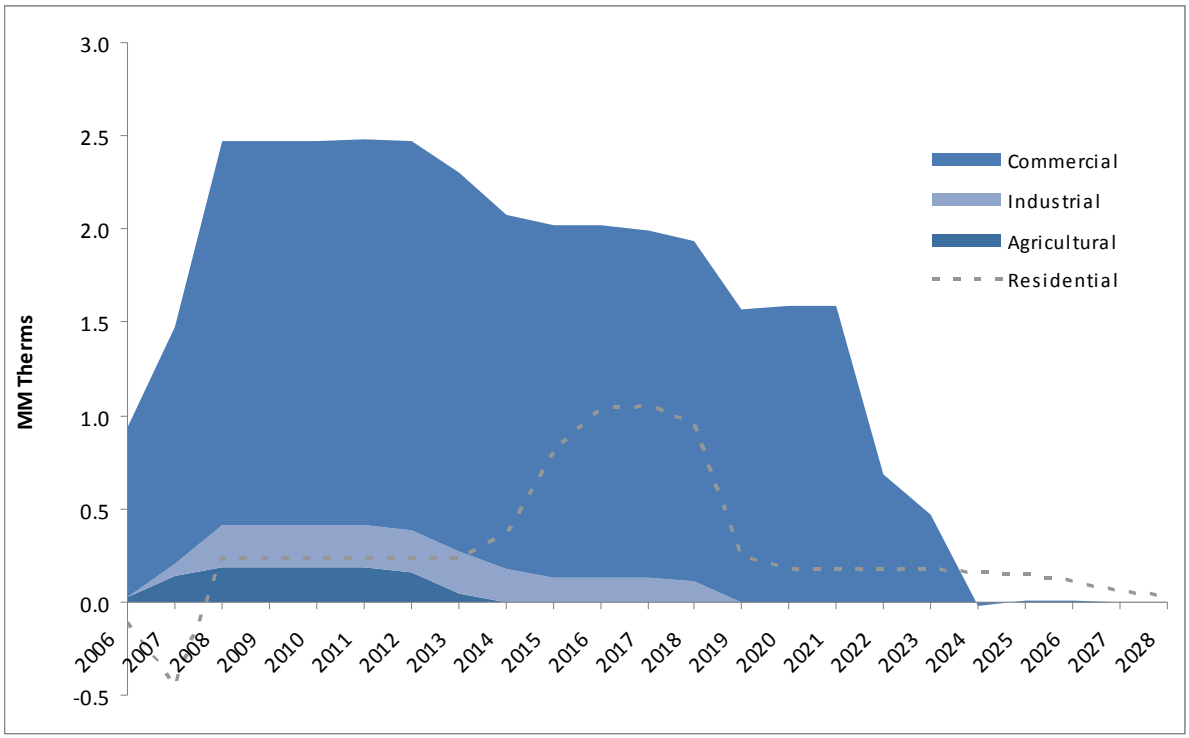


Figure 67. SDGE Lifecycle Stream of Natural Gas Savings through 2028



6. ESTIMATED EMISSIONS REDUCTIONS

One key benefit of the IOU energy efficiency programs implemented in 2006-2008 was the reduction in CO_2, NO_X, and particulate emissions that would have otherwise occurred in California. The CPUC uses an emissions rate for electric and gas savings that is dependent on the type of installed technology. The calculations for each technology are embedded in the E3 Calculators and, subsequently, the ERT that Energy Division used to estimate portfolio energy savings and other impacts.[73]

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.

NO_X and PM-10 equations are the same. Just replace $[CO_2]$ with the appropriate indicator. Note that CO_2 emission rate is in tons per kWh. NO_X and PM-10 are in pounds per kWh

The emissions results provided in this section are limited to the IOU-level results. The data extraction at the market or measure level was not available at the time of this report. Program level emissions results are provided in Appendix A.

6.1. Emissions impacts by IOU

The estimated emissions reductions achieved by participants in the IOU energy efficiency programs are approximately 4 million tons of CO_2, almost 2 million pounds of NOx and over 450 thousand pounds of PM-10 from 2006 to 2008. About two-thirds of these emissions reductions were the direct result of the program intervention. These estimated emissions reductions represent the annual impact of the energy efficient technologies when they are installed and operating. The sum of the emission impacts that can be expected if these technologies remain in place for their expected useful life is approximately 45 million tons of CO_2, 22 million pounds of NOx and 4.8 million pounds of PM-10 through 2024, and again about two-thirds of these emissions reductions were the direct result of program intervention. The value of the carbon emission reductions are included in the benefits side of the calculation of the Total Resource Cost test at 12 dollars per ton averaged over time; consistent with Commission policy in place for the 2006-2008 program cycle.

[73] The details of the calculations in the E3 calculator can be found in "E3 Calculator TechMemo 4a" pg 34 and is accessible for download at: http://www.ethree.com/downloads/index.php?path=E3+Calculators/ .It is important to note that the emissions calculations in the 06-08 E3 calculators are not the same as the most recent E3 GHG modeling project completed for the CPUC in 2009. http://www.ethree.com/cpuc_ghg_model.html .

Table 31. Annual and lifecycle emissions reductions by IOU

Data	PGE	SCE	SCG	SDGE	Grand Total
Reductions in CO_2 Emissions in Tons					
Gross CO_2	1,909,936	1,553,567	319,344	333,325	4,116,173
Net CO_2	1,201,013	1,046,414	171,916	222,786	2,642,128
Lifecycle Gross CO_2	21,914,044	15,992,515	3,438,345	3,676,759	45,021,664
Lifecycle Net CO_2	10,368,241	11,372,622	207,558	2,343,154	24,291,576
Reductions in NO_X Emissions in Pounds					
Gross NO_X	859,973	258,614	496,723	115,198	1,730,508
Net NO_X	624,811	182,620	267,730	81,310	1,156,472
Lifecycle Gross $NO_{X\,2}$	12,748,346	3,065,581	5,303,307	1,373,418	22,490,652
Lifecycle Net NO_X	9,834,327	2,156,689	2,781,210	982,198	15,754,424
Reductions in NO_X Emissions in Pounds					
Gross PM-10	211,934	215,487	540	40,362	468,324
Net PM-10	124,951	144,295	259	26,549	296,055
Lifecycle Gross PM-10	2,146,561	2,178,581	10,232	435,062	4,770,435
Lifecycle Net PM-10	1,314,044	1,470,660	4,783	299,350	3,088,838

Energy Division's 2006-2008 evaluations were charged with estimating savings that are directly attributable to the utilities' programs. The emissions impacts only reflect these energy savings impacts. Potential increases in market driven adoption of efficiency measures, or other market influences related to or outside these program activities likely result in even more significant emission benefits for society.

7. COST EFFECTIVENESS

7.1. Cost-Effectiveness methodology

For every dollar invested in energy efficiency through the IOUs' 2006-2008 energy efficiency programs, the state earned that dollar back, along with an additional $.14 in total resource benefits.

> *Cost Effectiveness is 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.*
> *Policy Manual V4; p2*

The energy efficiency programs implemented by the IOUs are subject to two cost effectiveness tests, the Total Resource Cost test and the Program Administrator Cost test.

As stated in the policy manual, the Commission relies on the Total Resource Cost Test (TRC) as the primary indicator of energy efficiency program cost effectiveness, consistent with the Commission's position that ratepayer-funded energy efficiency should focus on programs that serve as resource alternatives to supply-side options. The Total Resource Cost Test (TRC) measures the net resource benefits to all ratepayers by combining the net benefits of the program to participants and non-participants. The benefits are the avoided costs of the supply-side resources either avoided or deferred. The TRC costs encompass the cost of the measures or equipment installed [by the customer] and the costs incurred by the program administrator for both resource and non-resource program activities.[74]

$$\text{TRC} = \frac{\text{Benefits = Net Present Value of avoided costs of supply-side resources avoided}}{\text{Costs= Net Present Value of cost to participants + non rebate costs incurred by program administrators}}$$

The Program Administrator Cost (PAC) test should also be considered in program and portfolio cost-effectiveness evaluations. In a portfolio-level evaluation of cost effectiveness, the PAC test measures program benefits as the TRC test does, but costs are defined differently to include those incurred by the program administrator, for resource and non-resource programs but exclude those costs incurred by the participating customers.[75]

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

Because costs are specific to programs and it is not possible to disaggregate the benefits and costs to specific levels of measures or market sectors in a meaningful way, the cost effectiveness estimates provided in this report are limited to the portfolio and program levels. Table 32 presents the cost effectiveness of the portfolios as a whole, while the program level cost effectiveness ratios

[74] See Energy Efficiency Policy Manual v4.0 at http://www.calmac.org/events/EE_Policy_Manual_v4_0.pdf .

[75] (See the SPM link under Attachment A.) p.12 Appendix b .

are found in Appendix A. The costs included in the TRC test remove the costs to free-rider participants, since the benefits associated with those participants are excluded as well.

7.2. Cost Effectiveness of the 2006-2008 Programs

Table 32. Utility Reported and Evaluated Cost Effectiveness[76]

(Values in Million $)	Reported			Evaluated		
IOU	**Benefit**	**Cost**	**Ratio**	**Benefit**	**Cost**	**Ratio**
PGE						
Program TRC[1]	$3,110	$1,068,	2.91	$1,253	$1,069	1.17
Program PAC[1,2]	$3,110	$852	3.65	$1,253	$852	1.47
SCE						
Program TRC	$2,193	$984	2.23	$1,169	$984	1.19
Program PAC	$2,193	$638	3.44	$1,169	$638	1.83
SDGE						
Program TRC	$604	$276	2.19	$281	$276	1.02
Program PAC	$604	$206	2.93	$281	$205	1.37
SCG						
Program TRC	$471	$205	2.30	$184	$205	0.90
Program PAC	$471	$117	4.01	$184	$116	1.59
Statewide						
Program TRC	$6,381	$2,534	2.52	$2,886	$2,534	1.14
Program PAC	$6,381	$1,815	3.52	$2,886	$1,810	1.59

[1] B/C Ratio is an approximation because any supply cost increases are treated as negative benefits rather than as a cost as in the Standard Practice Manual

[2] PAC benefits include environmental costs. This is to be consistent with the TRC benefits, but is not strictly consistent with the Standard Practice Manual.

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 Table 32 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.

7.3. Context of the Results

The cost effectiveness rules that guide California energy efficiency planning and evaluation are outlined in more detail in the Standard Practice Manual[77]. These rules are embedded in the E3 calculators that are used both for reporting program accomplishments and planning programs. The

[76] The actual values for the TRC and PAC ratios were extracted from the "Results" tab of the E3 calculator in cells H16:H17 called B/C Ratio.

[77] See "California Standard Practice Manual" at ftp://ftp.cpuc.ca.gov/puc/energy/electric/energy+efficiency/em+and+v/Std+Practice+Manual.doc .

rules reflect current Commission policy for assessment of the cost effectiveness of these programmatic activities.

It is possible that several 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.

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. As discussed in Section 4, the "dual baseline" effects can both over- and under-estimate long-term savings and consequently distort the real value of the resource.

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 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.

8. ACCOMPLISHMENTS OF THE 2006-2008 ENERGY EFFICIENCY PROGRAM CYCLE

8.1. Programmatic Accomplishments

The energy savings achieved in the 2006-2008 program cycle are significant and will have a lasting impact on energy use and emissions over the life of the installed measures.

> Program participants achieved over 6,000 GWh, 80 million therms, and over 1000 MW in annual energy savings impacts for the three-year program cycle. Nearly two thirds of the electric savings were the direct result of the program interventions. Over the life of the technologies installed, the savings for program participants will be over 66,000 GWh and over 1,000 million therms. These estimated first-year savings are equivalent to the avoided construction of two power plants (based on the average-sized power plant of 500MW) and have resulted in 4 million tons of avoided CO_2 emissions, and the equivalent of 760,456 cars being removed from California's roads.[78]

In addition to the installation of millions of energy efficient technologies nearly 550,000 hours of training were attended by market actors, and 9.5 million households were reached by the statewide marketing campaign.

> Over 64 million compact fluorescent light bulbs were installed and are operating around the state in residential and commercial applications. Over 41 million square feet of insulation was installed through these program activities alone. 1.2 million new energy efficient household appliances were installed as a result of these programmatic activities. The IOU Energy Centers hosted 547,560 hours of training for nearly 40,000 unique attendees, which resulted in actions taken by market actors, commercial end users, and residential customers. The statewide marketing campaign reached 9.5 million households and on average increased awareness among those households 10-15% about ways to save energy in the home. The increase in knowledge was greatest among Spanish and Asian language speakers.

8.2. Evaluation Accomplishments

The administrative structure adopted for the 2006-2008 program cycle, which placed responsibility for independent evaluation with the Energy Division, has afforded the Commission numerous benefits including: the integration of evaluation results into programmatic improvements and procurement planning proceedings; an improvement in staff capacity for program implementation oversight; and unprecedented opportunities to perform consistent evaluations and develop consistent, non-proprietary datasets to inform future studies. All of these benefits augment the Commission's ability to fulfill its larger oversight mission.

[78] In estimating CO_2 emissions reductions associated with MMTherm and GWh savings, Energy Division used the emission factors that are embedded in the E3 calculators which are specific to each technology installed.

The 2006-2008 evaluation is the first time all portfolios were evaluated on a consistent basis with the use of the Evaluation Protocols as well as collaboration among the top evaluation professionals in the United States.

In addition to using the Evaluation Protocols adopted for this program cycle to design evaluations, the evaluation consultants and Energy Division developed methods for and approaches to evaluation through consensus, consequently producing stronger evaluation results. The Net to Gross Working Group and the Engineering Working Group were each developed across contracts and instituted uniform procedures to be followed by all evaluation teams, consistent with Commission policy. Advisory consultants also added to the breadth of perspectives, which ultimately strengthened the studies. In combination with sufficient funding, the resulting evaluations were more rigorous than have been accomplished in the recent past.

The 2006-2008 evaluation is the first time consistent data sets were compiled across IOUs at the technology level. This was accomplished with the cooperation and significant contributions of the IOUs and enabled aggregation of savings and other parameters across IOUs, technologies, and programs.

This is the first time in the history of California energy efficiency that an aggregated, standardized data set of the IOU program tracking records has been compiled. This was accomplished with the cooperation and significant contributions of utility staff and Energy Division contractors. The value of this dataset lies in the ability to aggregate across utilities, measures, and programs and compare claimed and evaluated results at the technology level. A non-confidential version of this data set will be made available to the California Energy Commission to aid in their updates to the end-use forecast in the next IEPR proceeding, and will be part of a larger data warehouse to use for future evaluation studies.

Energy Division is compiling raw evaluation data from the 2006-2008 cycle that will be centralized in a single location as a rich body of non-proprietary data to use in future analysis.

Energy Division is in the process of compiling all evaluation data sets into one centralized location. These datasets will be made available to future evaluation contractors and the IOUs to conduct additional analyses, potentially expand datasets for future evaluations, and inform DEER updates. In addition to survey data, the datasets will include significant amounts of field data, including hours of use from lighting loggers and usage profiles for many technologies. This is the first time the raw data has been housed centrally and will be the foundation for a rich body of non-proprietary data to use in future analysis.

The 2006-2008 evaluations produced several innovations in methods and approaches and an overall ability to "dig deeper". The innovations in the evaluation design, particularly using a measure-based approach (HIM), resulted in greater confidence in the savings for existing technologies.

Over the course of the 2006-2008 cycle, there were several innovative methods that were tested. While sample sizes may have been low for some contract groups, the depth of analysis on many of the custom projects was increased significantly. The focus on specific energy efficient measures strengthened the evaluation results for the most

common measures through increased sample sizes and the application of consistent methods regardless of the program in which the technology appeared.

The 2006-2008 evaluations represented one of the largest energy efficiency evaluations in the world.

Energy Division staff managed an evaluation budget of $97 million spread across 23 technical contracts and under strict timelines, a public review process, and high expectations**.** In addition several process evaluations led by the IOUs were also conducted on this cycle of programs to understand program successes and shortfalls**.** The magnitude of this evaluation activity was remarkable. It required establishment of multiple technical contracts to complete the work and compliance with strict, predetermined timelines designed to synchronize with the Commission's desire to determine earnings on an annual basis. Energy Division met its obligations in terms of delivering quality product within these timelines as well as facilitating public comment. Energy Division hosted over 60 public meetings, and reviewed and addressed over 1,700 comments on the 17 completed resource and non-resource impact evaluation reports.

Energy Division staff has built significant capacity over the past three years in understanding the IOUs' energy efficiency programs and fulfill the Commission's oversight responsibilities. Energy Division currently has nine staff members dedicated to program evaluation and another seven staff members dedicated to program planning oversight. Staff now has experience in evaluation study implementation, particularly the intricacies of study design and implementation to conform to Commission policy. The close interaction of Energy Division's energy efficiency evaluation and planning staff provides further assurance that evaluation results will be incorporated into future program design.

IOU program managers and Energy Division staff are currently meeting to ensure that the results of the specific evaluation studies are being considered for improving savings estimates and program design for the 2010-2012 program portfolios.

These meetings are intended to identify the specific ways to address the impact and process evaluation findings through program modifications. The IOUs are scheduled to report back on these plans at the end of May 2010 and Energy Division will oversee the implementation of these plans.

Energy Division's evaluation staff is collaborating 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.

Energy Division staff is an active participant in the Demand Forecast Energy Efficiency Quantification Project working group with colleagues in the Long Term Procurement section of Energy Division, the California Energy Commission demand forecast team, California Air Resources Board and other stakeholders. Energy Division's participation ensures 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. As a result of this collaboration the 2010 Long Term Procurement Plan

proceeding (LTPP) will consider these findings as it works to determine procurement needs. The LTPP will also consider the likelihood of long term energy efficiency accomplishments based on the California Energy Commission's committed and incremental-uncommitted forecasts as well as scenario analyses by parties that will be entered into the proceeding. Neither the committed nor incremental-uncommitted forecasts had the final evaluations results for the 2006-2008 cycle available at the time of their creation, but the savings may be updated in that model in the 2012 IEPER.

Energy Division staff is also providing in-depth evaluation-based results to inform the Risk Reward Incentive Mechanism proceeding for 2006-2008.

This proceeding will consider the results with respect to the earning calculations for the IOUs, as required in D. 09-12-045.[79] A separate report will be issued May 4, 2010, to directly inform that proceeding and form the basis for the final earnings claims.[80]

[79] Available at: http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/111876.htm .

[80] 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. Available at: http://docs.cpuc.ca.gov/EFILE/RULINGS/116024.htm .

9. ENERGY DIVISION KEY RECOMMENDATIONS

9.1. Recommendations for Programmatic Changes

1. Results from the evaluations should be used for improving savings estimates and informing program design in the 2010-2012 cycle and beyond.

The evaluation studies completed for 2006-2008 offer a wealth of information that may be used to improve and update savings estimates and modify program design for the 2010-2012 program cycle. Many of the same technologies installed in 2006-2008 are the foundation for energy savings in the 2010-2012 portfolios and the savings estimates from the 2006-2008 evaluation studies should be considered where appropriate in refining the savings estimates for programs for the 2010-2012 program cycle. By incorporating these values into improved program planning for the 2010-2012 program cycle, the IOUs and Energy Division will achieve an important evaluation milestone and close the loop of evaluation and planning. Energy Division staff is currently meeting with IOU program managers to review the specific results and plot a course for program modifications to maximize savings potential for these programs in the 2010-2012 program cycle and beyond.

2. 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.

Every evaluation study recommended improvements in data tracking and reporting to improve program operations and evaluation. Improved data collection will enhance the ability to verify installations, asses the appropriate baseline, and track program progress. A common technology naming convention is being developed in collaboration with the IOUs for the 2010-2012 program cycle. Additionally, the Commission is working with the IOUs to develop a standardized reporting structure to limit excessive outlays on dataset reconciliation and eliminate the need to create a consistent data set (as was necessary in 2006-2008).

3. Program implementers should ensure that program rules guiding eligibility are followed.

In the course of the 2006-2008 evaluations there were energy efficiency projects for which the savings claims were inconsistent with existing program rules. These included: providing incentives for projects that were already completed or equipment that was already installed prior to the rebate application; using the incorrect baseline; failing to accurately collect or report data required by Commission policy and the evaluation protocols; and failing to properly adjust savings parameter estimates that were claimed but not in compliance with the rules. For example the determination of baselines was inconsistent with program rules in certain project implementations, including those within Commercial Facilities, PGE Fabrication, and Southern California Industrial/Agricultural evaluations. Consequently, evaluators had to adjust savings to properly reflect the program rules. Examples included eligibility for pipe insulation, not adhering to fuel switching rules, and rebates for repairs that were not clearly retro-commissioning. Additionally, rules regarding data collection were not followed or

properly enforced, and resulted in discrepancies in savings between reported and evaluated results. These instances occurred in both the Major Commercial and Residential Retrofit evaluations. Had the rules been clearly delineated at the onset of the program cycle and strictly enforced, the savings discrepancies would have been smaller.

4. Program implementers should screen large project participants to ensure that net savings are achieved, not those that would have occurred absent the program.

The evaluation reports for programs with custom projects recommended limiting or excluding incentive payments to known free riders with the use of early project net to gross and baseline screening for the largest projects and those with significant policy issues like fuel switching, self generation, and greenhouse gas impacts. Account representatives may not be properly incentivized to go after incremental savings, and utility policies guiding their compensation should be oriented to make sure they are pursuing incremental savings instead of rewarding customers who are already aware of available incentives and may have energy managers in place.

5. The IOUs' energy efficiency program portfolios should diversify the programs and measures they offer so savings are not heavily concentrated in one measure or market delivery strategy as was the case with standard compact fluorescent bulbs in the 2006-2008 program cycle.

In 2006-2008 over half of the statewide savings were attributable to residential compact fluorescent bulbs promoted through the upstream market program. The original portfolio applications approved by the Commission included a smaller projection of bulbs to be promoted in this way, but with more optimistic savings estimates. The Commission's approval of the portfolio included strong warnings that the evaluated savings were likely to be much lower based on data that was available in 2004. Despite these warnings, only one IOU reduced the savings assumptions, while other IOUs ramped up bulb installations. In the end the evaluation found only about 25% of the reported CFLs to be installed and operating.

9.2. Recommendations for Evaluation Changes

6. Energy Division should continue to improve on collaboration with implementers and other stakeholders to build the value of evaluation products and results.

In the 2006-2008 evaluation cycle Energy Division engaged stakeholders throughout the evaluation period in a public review and comment process that was consistent with the framework established for the program cycle. Over 60 public meetings were held regarding the evaluation plans and results and over 1,700 comments were reviewed and considered in finalizing the evaluation reports. However, energy efficiency program evaluation administered under the existing policy framework of high-stakes utility shareholder incentives presents significant challenges to balancing the regulatory obligation for independent IOU program implementation oversight with the need to establish collaborative working relationships between evaluators and implementers. The Commission must continue to build a policy framework that facilitates improved collaboration between the IOUs, Energy Division, evaluators, and stakeholders.

For the 2010-2012 evaluations Energy Division staff and the IOUs agreed to develop a more collaborative and transparent working relationship as an important step toward improving the EM&V process. The agreed upon goal of "collaboration" is defined as IOU and ED staff working together on shared EM&V projects, as well as working on separate EM&V projects following mutually agreed upon standards for transparency, respect, and communication. Energy Division believes that this more collaborative process will result in greater cost-efficiencies, more reliable results, broader stakeholder buy-in, and fewer disputed issues.[81] .

7. 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.

Evaluation results should be integrated into planning and updated estimates of savings, and this may be achieved by establishing a continual feedback loop. Energy Division recognizes that feedback provided at the conclusion of a program cycle is less than desirable, as it may limit timely adaptation of programs based on findings in the field.

However, this lag is not unique to the 2006-2008 cycle as updated savings assumptions based on evaluation have historically lagged. For example, evaluation studies for several of the major programs in the 2004-2005 portfolios were not completed until the end of 2008 due to a variety of factors, consequently limiting the opportunities to update values and make necessary program changes. While the gap in delivering evaluation results has been shortened significantly for the 2006-2008 cycle, it still affects the ability to adopt (either voluntary or mandated) adjustments to program implementation or to planning assumptions.

In order to deliver mid-course results, it would be necessary to adopt a strategy that incorporated a different evaluation plan time dimension that might not perfectly synchronize with the Commission's use of evaluations to determine shareholder incentives, could result in some additional costs and would require greater coordination between all parties. To generate truly useful information, mid-course reporting must produce updates to meaningful parameters that have significant realization uncertainties, not just installation rates. The individual evaluations would have to be scheduled to serve the program and policy needs, and not be dominated by the need to comply with the procedural schedules for determining IOU earnings. Alternatives for more timely feedback on evaluation results could involve strategies to stagger the evaluations, conducting continuous evaluations, and/or designing the impact studies to address the most variable aspects of the savings estimates and updating the deemed savings estimates on an ongoing basis. These options, and many others, are being explored for the 2010-2012 program and evaluation cycles and beyond.

8. 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.

[81] See D.10-04-029 Available At: http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/116320.htm .

The evaluations conducted for the 2006-2008 program cycle did not include a review or analysis of incremental measure costs. A comprehensive incremental cost study is necessary, but was not part of the evaluation activities in this program cycle. In addition to a comprehensive study, review of the cost data submitted by the utilities should also be given closer scrutiny. Incremental cost data is not consistently provided at the program tracking level and the estimates provided in the E3 calculator are likely out of date, not always incremental, and pose considerable problems with accurately estimating the cost effectiveness of the portfolios. Energy Division intends to integrate review of costs into the 2010-2012 evaluations and launch an incremental cost study.

9. Early notification strategies should be implemented to enable analysis prior to installation of the technology or action taken in order to better capture the impact of the intervention.

More pre-post measurement, particularly for large and custom projects, will allow implementers and evaluators to share a common understanding of what action is being taken, instead of having to re-construct the situation after the fact. This will require evaluation teams to respond when projects are implemented and a continuous stream of data and information from the utilities regarding pending projects. While such a strategy may not be practical for all projects, establishing a threshold of the largest projects for which it may be used would represent a significant improvement in evaluation methods. This kind of strategy could also enable pre-screening for net to gross on the project.

9.3. Recommendations for Policy Changes

10. 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.

The evaluation framework, rules and policies established for the 2006-2008 program cycle were based on the definition of energy efficiency as a discrete resource derived from the installation of energy efficiency technologies and its placement as first in the loading order. At the time, there was no AB 32, nor was there a California Strategic Plan for Energy Efficiency.

The Commission has already expanded the interpretation of the utilities' role in achieving energy savings in the longer term, first by adopting a goals structure in 2008[82] that defined the goals for 2010-2012 as "gross" and a subsequent "total market gross" goals structure for post-2013. This approach measures all savings achievements within IOU service territories and "begins to solve the crucial interagency need for a metric appropriate to load forecasts, associated emission reduction baselines, and economically efficient procurement plans."[83] Additionally, the California Strategic Plan

[82] See D. 08-07-047 at http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/85995.PDF .

[83] 2008 Goals Decision: D. 08-07-047; July 31, 2008 http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/85995.PDF; D. 08-07-047, the "Decision Adopting Interim Energy Efficiency Savings Goals For 2012 Through 2020, and Defining Energy

for Energy Efficiency provides a road map for long term energy efficiency improvements. Each of these policy decisions has a direct impact on evaluation focus and methodology, and together they suggest the need for a more comprehensive approach to evaluation.

Consequently, the evaluation framework for 2010-2012 will incorporate studies that inform implementation of the Strategic Plan objectives, add evaluation elements that focus on consumption analysis, and include performance metrics. These design elements are in addition to impact evaluation activities that are necessary to quantify the savings from technology installations. The importance of measuring incremental savings should be reconsidered in the context of energy efficiency programs increasingly focused on market transformation, strategic planning, and gross goals Regardless, methods used to determine attribution must be updated in light of the recent expansion of other federal, statewide and local initiatives to pursue energy efficiency.

Nevertheless, the Commission should moderate its expectations for evaluation activities in terms of the number of issues and the timeframes during which these issues can be examined, given available resources.

11. The Commission should 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.

The implementation of the 2006-2008 incentive mechanism has revealed fundamental flaws which once again leads Energy Division to propose that the EM&V process, at least as it is currently designed and administered, cannot serve as a tool to simultaneously determine incentive awards or penalties and produce accurate estimates of energy savings without protracted disputes concerning the magnitude of specific values or the fairness of allowing those values to be updated and applied retroactively.[84] Energy Division believes that the current incentive mechanism does not optimally align the IOU management and shareholder interest to serve the loading order policy, the CEESP, or the GHG emissions reduction goals mandated by AB32. The load reductions attributed to the IOU portfolios must be accurate and reliable to be taken seriously in resource planning activities. Similarly, the estimates of GHG emission reductions must be genuine if California's claimed progress in reducing GHG emissions is to be taken seriously. To be effective, the incentive mechanism must focus the IOU energy efficiency efforts on providing genuine and accurately measured progress towards these two objectives. Energy Division's primary concerns regarding the current incentive mechanism are twofold: first, implementation of the incentive mechanism has become a diversion that has consumed too much valuable and limited staff time within the IOUs, other stakeholders, and the CPUC, and second, the incentive mechanism has focused attention on the details of the calculation of incentive amounts rather than on the delivery of exceptional programs that reduce energy consumption and GHG emissions, and serve as the foundation for fundamentally changing the way Californians use energy.

Efficiency Savings Goals for 2009 Through 2011" utilized an updated potentials study, and goals study (by Itron) to develop Total Market Gross goals for 2012-2020. pg 13.

[84] See Energy Division's APRIL 2009 WHITE PAPER.

APPENDICES A-P

The following appendices are provided in a separate document due to size constraints.

A. Results from the ERT: Evaluated Energy Savings at the Program-Level

B. Description of HVAC Interactive Effects Factors

C. ERT Input Summary tables by Contract Group and documentation files

D. Policy Direction on ED options for Extrapolating Results

E. Requirement for the application of the DEER 2008 updates

F. Dual Baseline Memo

G. ERT Quality Control Activities

H. Evaluation Reporting Tools (ERT)

I. Standard Program Tracking Database March 2010v.8

J. ERT Input Sheet Documentation

K. ERT Application (Clean)

L. ERT Application (With Data)

M. ERT Input Sheets

N. Standard Program Tracking Database

O. Responses to Public Comments

P. History of California Public Utility Commission Goals for Energy Efficiency