IMPACT EVALUABILITY ASSESSMENT OF CALIFORNIA'S CONTINUOUS ENERGY IMPROVEMENT PILOT PROGRAM

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Legal Notice

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Executive Summary

The California investor-owned utilities (IOUs)—Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), and San Diego Gas & Electric (SDG&E)—currently administer the Continuous Energy Improvement (CEI) pilot program. The pilot was launched in early 2010, and the IOUs recruited participants in late 2010 and in 2011. The program provides long-term energy-management consulting services that educate and train commercial and industrial energy users to: (1) develop and execute a long-term energy-planning strategy, and (2) integrate energy management into their business planning permanently.

A process evaluation of the pilot program was completed by Cadmus in 2012.[1] The California Public Utilities Commission Energy Division then engaged Cadmus to assess the evaluability of the CEI pilot in its early stages and provide recommendations for improving data collection. This document reports the results of the evaluability assessment of the pilot program, examines appropriate statistical methods that might be used to assess the program's impacts and applies these methods to data for a small number of facilities to test their applicability.

Program Goals and Evaluation Methodology

The IOUs' primary purpose in offering the pilot program was to examine alternative options and to develop workable methods for implementing CEI programs in their service territories. The evaluability assessment goals were these:

- Assess the evaluability of the CEI program based on the data collected thus far and recommend improvements to data collection, and
- Demonstrate the methodology for determining future energy savings from CEI.

Cadmus conducted the evaluability assessment and then estimated the energy savings for facilities with sufficient data. We selected two sites from each of the five third-party CEI advisors so that we could assess the availability and usefulness of the data collected by the CEI advisors and the data quality's impact on the ability to estimate energy savings.

Cadmus estimated the energy savings with regression analysis, using facility information, billing data, production data, and weather data. Our estimation approach also accounted for capital projects completed during the baseline and pilot test periods, so that savings from O&M projects could be isolated. The results of this assessment served as the basis for our recommendations for improving the data collection process.

1 Cadmus. *Process Evaluation of California's Continuous Energy Improvement Pilot Program.* October 2012. Prepared for the California Investor Owned Utilities.

Key Findings

The key findings and the resulting recommendations are as follows.

Data Completeness

Cadmus received all of the data needed for assessing the energy savings, except capital measure cost required for calculating cost-effectiveness. All five CEI advisors collected the relevant data and all provided similar data; it was apparent that they followed the IOUs' data collection guidelines.

Recommendations:

- The CEI advisors should continue following the data collection guidelines developed by the IOUs.
- The IOUs and CEI advisors should collect the installed cost for capital measures so that cost-effectiveness can be calculated.

Ability to Calculate Energy Savings

Based on the results of this and other studies of CEI programs, regression analysis provides a reasonably reliable method for estimating the impacts, subject to several considerations, most importantly availability and completeness of data.

Conclusions for the Four Facilities That Were Not Modeled

Although all of the relevant data were collected for calculating energy savings, we were unable to detect savings at four of the eight facilities that had entered the implementation stage. The monthly production and billing data for three of these four facilities did not have enough observations for the post-implementation period to provide an adequate basis for estimating the regression models. The fourth facility had installed a large number of capital projects both before and after implementing CEI, making it difficult to establish a reliable baseline for estimating O&M energy saving impacts.

Recommendations:

- **Conduct the impact evaluation after two years.** For a future CEI program, the impact evaluation should be conducted after facilities have participated for two years. This will provide enough time for all facilities in the program to have their CEI plan in place and to have implemented projects and will provide sufficient post-implementation period data.
- **Perform a statistical power analysis before enrolling a facility in the CEI program.** A statistical power analysis (or fractional savings analysis) would yield an *ex ante* **probability** of detecting a site's energy savings with the available data. When beginning an engagement with a site, we recommend that the CEI advisor perform such an analysis. The analysis would require assumptions for each site about the significance levels (e.g., 20%), expected percentage of savings, the coefficient of variation (CV) of energy use, the correlation between baseline and test period energy use, and the number of baseline and test period observations. The IOUs could use energy use data in the baseline period to develop assumptions about the site CV and correlations. Then, the IOUs could use the statistical power analysis to determine whether the baseline and test periods are sufficiently long (i.e., the number of days, weeks, or months) for

detecting savings. If the analysis shows a low probability of detecting savings, then the facility should be required to collect data for a longer period or more frequently (e.g., daily instead of monthly) in order to participate in the program.

- **Extend the length of the baseline period.** It can be difficult to establish a baseline at facilities that install capital and O&M measures during the baseline period, especially if these projects occur two to three months before implementing CEI. Providing an additional year of baseline data for these facilities could improve the regression estimates.

Conclusions for the Four Modeled Facilities

One of the four sites where we estimated energy savings underwent a facility renovation shortly after beginning CEI, which caused an increase in electricity and gas consumption that was not representative of program impacts.

The energy savings results for the remaining three sites were as follows:

- PG&E 1: Electricity savings were 4,068 MWh per year, representing 5.2% of baseline electricity consumption. Gas savings were 0.34 million therms per year, accounting for 2.3% of baseline gas consumption.
- PG&E 2: Electricity savings were not statistically different from zero. Gas savings were 1.406 million therms per year, accounting for 17.6% of baseline gas consumption.
- SCE/SCG 1: Electricity savings were not statistically different from zero. Gas savings were 0.116 million therms per year, accounting for 2.0% of baseline gas consumption.

Cadmus encountered these challenges in attempting to detect energy savings for the remaining four pilot program participants.

- ***Timing of Measure Implementations.*** The energy savings for O&M measures installed near the end of a program year may not be estimated precisely, due to the lack of sufficient post-implementation data.
- ***Other Events at the Facility Can Confound the Analysis.*** As our experience with one facility showed, CEI impacts will be difficult, if not impossible, to detect in facilities that undergo major renovation and/or expansion shortly after enrolling in CEI. These changes will potentially lead to large increases in the facility's energy use and are hard to control for in the regression analysis. This is especially the case where the project lacks sufficient post-CEI and pre-renovation billing and production data.
- ***Large Confidence Intervals around Results.*** The 80% confidence intervals for the energy savings were large, reflecting significant uncertainty around the precision of the estimates. In our judgment, the statistical performance of the results would improve with longer pre- and post-CEI data or with higher frequency (daily or weekly) billing and production data.

Recommendations:

- **Collect billing and production data at higher frequencies.** When estimating energy savings with regression, the probability of detecting savings increases with higher data frequency. Savings are more likely to be detected with daily or weekly data than monthly data. Also, the confidence intervals are likely to be smaller with daily or weekly data than monthly data. The statistical power analysis mentioned above will provide guidance as to what data interval is most appropriate for a site. If a site shows a high correlation between energy consumption and production and weather variables, then monthly data may be sufficient.
- **Provide engineering calculations for capital measure savings.** When modeling the O&M measure savings, one method to account for the capital measure savings is to adjust electricity consumption upward to account for the lower energy use caused by the measure's implementation. This adjustment is most useful when capital measures have been installed in the same period as O&M measures and their impacts are not seasonal. The IOUs could aid the evaluation by providing the *ex ante* saving calculations, especially where the measures were installed under an IOU-sponsored program.
- **Track large facility events during enrollment.** If a facility has planned for any large events outside of CEI that impact energy use, such as renovations or major changes to plant operations, they should not be eligible for the CEI program as it will not be possible to estimate energy savings. Facilities that implement these types of projects after participating in CEI should be required to inform their CEI advisor and IOU, who would then decide whether the facility would be eligible to continue in the program, or would be a more appropriate participant in another program. It may be possible for a facility to temporarily suspend participation in the CEI program while renovations or other non-CEI changes are taking place - and to continue with CEI later.
- **Consider metering capital projects.** In some instances where both capital and O&M measures are implemented within a short period of time, metering the impacts of capital project(s) should be considered if the IOUs would like to report capital savings separately from O&M savings. Applying regression analysis to measure savings from O&M requires that the savings from O&M and any capital measures be sufficiently independent (uncorrelated). An overlap between implementation of capital and O&M measures will make it difficult to estimate their separate impacts.

Other Considerations

Reporting Energy Savings Results

In estimating the savings attributable to CEI, it is important to account for a facility's participation in other IOU-sponsored programs. The documentation must identify measures that received incentives through other programs. The savings associated with these measures can then be properly accounted for when estimating the CEI impacts.

The CEI plan documents measures that were recommended by (and originated in) the CEI program. For example, a building that installed a new HVAC system recommended by the CEI program may have received an incentive for this equipment through a different program, and that program may have claimed those savings. However, these savings should be acknowledged so that the full value of the CEI program is recognized.

Therefore, Cadmus recommends reporting electric and gas savings for three scenarios:

- Total savings (which encompasses all implemented measures);
- Savings attributable to CEI (which is calculated by subtracting the savings for measures incented by other programs from the total savings); and
- Savings that originated with CEI (which is calculated by subtracting the savings for measures that did not originate as a CEI program recommendation from the total savings.)

Determining Free-Ridership and Spillover

To assess free-ridership, it will be necessary to review documentation and interview facility staff about individual measures. This is because the best candidates for CEI are those facilities that were already interested in energy efficiency and likely to take some actions on their own. These candidates are more likely to receive management support to devote staff time to energy management. Therefore, many facilities are likely to be at least partial free-riders. However, the CEI program will encourage facilities to go beyond what they would have done on their own. It is therefore necessary to ask about individual measures to find out what projects the facility was already planning to implement on its own and what projects were motivated or accelerated due to participation in the CEI program. Participant spillover will be captured qualitatively in the facility's documentation of implemented projects and quantitatively with the regression analysis result for total facility energy savings.

To assess non-participant spillover, Cadmus recommends conducting non-participant surveys that ask questions about the extent of implementation of each CEI element. The survey results would show what percent of non-participating facilities have fully implemented CEI on their own or with assistance from outside the CEI program. In addition, the survey results would provide the IOUs with useful information about what facilities are doing on their own and what CEI elements facilities need assistance with.

Determining Persistence

The IOUs goal with the CEI program is to provide information and education to encourage facilities to manage their energy consumption on their own. However, this type of training program is new, and

there has been little research to determine the persistence of behavior changes brought about by the CEI program. The intent of the IOUs' program is for facilities to incorporate CEI into their culture, so we recommend that, to the extent possible, the IOUs continue to collect data after a facility disengages with CEI. Measuring persistence would inform the measure lives used for projects in the cost-effectiveness analysis.

Persistence of CEI may be assessed using either quantitative or qualitative approaches. If the IOUs wish to quantify the persistence of energy savings from CEI, then production data should be collected. This information, along with the billing data, can then be used to measure energy savings and to quantify CEI persistence. Alternatively, persistence may be assessed qualitatively through periodic interviews with the facilities that have graduated from the CEI program to gather information on energy use behaviors and CEI-related practices.

Introduction

The California investor-owned utilities (IOUs)—Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), and San Diego Gas & Electric (SDG&E)—currently administer the Continuous Energy Improvement (CEI) pilot program. The pilot was implemented in early 2010, and the IOUs recruited participants in late 2010 and in 2011.

About the CEI Pilot Program

With the CEI pilot, the IOUs are exploring alternative strategies for achieving electricity and gas savings in the commercial and industrial sectors. By implementing a holistic energy-management approach that extends beyond replacing inefficient equipment, the CEI program strategy differs from the traditional energy-efficiency programs offered by the IOUs. The CEI program provides long-term consulting services for educating and training participating businesses' staff to do the following: (1) develop and implement a long-term energy planning strategy; and (2) permanently integrate energy management into their business planning at all organizational levels, from the shop floor to corporate management.

The IOUs' approach to delivering the CEI pilot encompasses organizational structures, energy systems, and energy and output tracking, as these elements are essential to effective energy management. While participation in CEI may result in clients making changes regarding specific energy-related actions, energy-efficiency measures, and capital projects, the program emphasizes positioning energy as an input to business operations, thus, managing it for maximum value.

The CEI program has six participation stages:

1. Commitment
2. Assessment
3. Planning
4. Implementation
5. Evaluation
6. Modification

The CEI pilot requires commitment and support from the upper management at each participating business. Specifically, upper management commits to guaranteeing funding and support for proposed energy-efficiency projects *and* ensuring that staff will receive energy-efficiency education and training.

After a facility commits to CEI, the CEI advisor conducts an organizational assessment that:

- Examines management's effectiveness regarding energy use, and
- Provides an understanding of the strengths of the current management process and areas for improvements.

This assessment also entails an energy audit, which may reveal opportunities for efficiency upgrades that can take advantage of other energy-saving offers from a utility.

After the assessment, the CEI advisor works with facility staff to develop a list of recommendations for reducing electricity and gas consumption. The advisor also aids facility staff in planning by helping to: (1) prioritize recommendations, and (2) develop short- and long-term energy reduction goals. The facility then begins implementing the plan.

Between six months and one year after implementation (depending on how quickly the facility implemented its plan), the plan is reevaluated and, as needed, modified. Because CEI is focused on long-term energy management planning, participating facilities are generally engaged in the program for from one to two years. During this period, the IOUs and CEI advisors provide support and resources that enable the managers of the facility's business to refine their company goals and energy management strategies.

One of the pilot goals was to determine which business segments would benefit the most from CEI; thus, CEI advisors recruited a diverse group of participants from the commercial, industrial, and agricultural sectors. Ultimately, approximately half of the participants were food processing facilities. This likely occurred because at least two CEI advisory firms had previous experience in implementing strategic energy management efforts in food processing facilities in the Northwest. Thus, the recruitment efforts of these CEI advisory firms were most successful with facilities from those same companies that had locations within California.

To be considered for participation, a customer must first commit to the program. The program participants involved in Cadmus' evaluation have progressed past the commitment phase and are at various stages within the CEI process, ranging from assessment through modification. Table 1 shows the number of pilot program participants (by segment) for each IOU, as of October 2012.[2] Recruitment for the program ended in late 2011, because implementing CEI requires at least a year and the pilot was scheduled to run through the end of 2012.

2 Note that PG&E added one food processing participant to one of its cohorts since the process evaluation report was published in 2012. PG&E was the only IOU to test a cohort model, where more than one facility from a parent company could participate in the program.

Table 1. Number of CEI Participants by IOU and Segment

Segment	PG&E	SCE/SCG	SDG&E	Total
Food Processing	12	6	1	**19**
Manufacturing	1	3	1	**5**
Smelter	0	1	0	**1**
Laundry	0	2	0	**2**
Hotel	0	1	0	**1**
Restaurant	0	1	0	**1**
Retail	0	1	0	**1**
Government	0	1	0	**1**
School	1	1	0	**2**
Office	1	0	1	**2**
Corporate Office	3	0	0	**3**
Biomanufacturing	1	0	0	**1**
Total	**19**	**17**	**3**	**39**

Note: This is the number of unique facilities; some companies have more than one participating location.

Evaluation Goals and Objectives

The IOUs' primary purpose in offering the pilot program was to develop workable methods for implementing CEI programs in their service territories and to establish the necessary methods and data-collection procedures that may be used to quantify impacts for a future CEI program. The program design and implementation processes were analyzed in an earlier report by Cadmus.[3] This report focuses on assessing the evaluability of the CEI program by identifying the data elements necessary to quantify the program's impacts, determining the availability and quality of the data currently being collected, recommending ways the data collection procedures might be improved and demonstrating a statistical method for estimating the CEI impacts.

[3] Cadmus. *Process Evaluation of California's Continuous Energy Improvement Pilot Program.* October 2012. Prepared for the California Investor Owned Utilities.

Evaluability Assessment Site Selection and Data Collection

Across the three programs offered by PG&E, SCE/SCG, and SDG&E, there are five CEI advisors, so Cadmus selected two sites from each CEI advisor. Having these 10 sites enabled us to compare the quantity and quality of data collected by each advisor and to develop recommendations regarding data requirements for subsequent evaluations. We also wanted to limit our review to those facilities that were—at a minimum—in the implementation stage at the time we requested the data (October 2012). However, this was not possible, as only 22 of the 39 participating sites met this condition and, therefore, were eligible for inclusion in the assessment. (Several of the participants enrolled in the CEI program in late 2011, so they were still in the planning stage when we selected the sites.)

Table 2 shows the number of program participants at each stage of CEI. These facilities represented four of the five CEI advisors; one CEI advisory firm did not have any facilities that had progressed past the planning stage. Still, for the purpose of assessing evaluability based on data collected to date, Cadmus included two facilities that receive guidance from the advisory firm in SDG&E's territory.

Table 2. Participants' Progress in the CEI Program as of October 2012

IOU	Commitment	Assessment	Planning	Implementation	Evaluation or Modification	Completed
PG&E	0	2	9	6	0	2
SCE/SCG	0	0	3	11	3	0
SDG&E	0	0	3	0	0	0
Total	0	2	15	17	3	2

In total, we selected 10 of the 39 facilities for inclusion in the assessment, two from each CEI advisory firm. For the two facilities in the planning stage, we conducted only an evaluability assessment of the data adequacy. Our goal was to have sufficient data from at least five of the remaining eight facilities to estimate the electric and gas savings. Our test sites consisted of:

- Two participants from PG&E (representing one CEI advisor)
- Six participants from SCE/SCG (representing three CEI advisors)
- Two participants from SDG&E (both in the planning stage and only receiving an evaluability assessment, representing one CEI advisor)

So that we could calculate savings, we requested that the IOUs provide the following data elements for each of the eight sites in or past the implementation phase:

- Facility characteristics, including the main drivers of electric and gas consumption;
- Date the facility signed commitment to CEI;
- Facility's CEI plan;
- List of projects implemented and project-related information such as the date implemented, a detailed measure description, and an estimate of energy savings, if available;

- Information about other events that impact energy use, such as a facility expansion or changes to work schedules;
- Production data; and
- Customer electric and gas billing data for two years prior to participating in the CEI program and for one year after.

Evaluability Assessment Details

To determine whether there were sufficient data to estimate the energy savings and calculate program cost-effectiveness, Cadmus conducted an evaluability assessment. This entailed reviewing the pilot project documentation and data and assessing whether the billing data and facility production data we received from the IOUs were sufficient (that is, whether the data were collected at intervals appropriate for detecting energy savings).

Data Completeness

Within the data provided by the IOUs, we looked for the following elements, which are necessary for conducting an impact evaluation:

- Facility characteristics, including business type and the main drivers of electric and gas use;
- Facility location (so we could download local weather data for the regression analysis);
- Date the customer signed the memorandum of understanding or letter of participation to participate in the CEI program (considered the date the customer began CEI);
- Electricity and gas billing data for two years prior and one year after participating in CEI;
- List of operation and maintenance (O&M) measures and capital measures implemented and the implementation dates;
- Energy-savings estimates for the capital measures; and
- List of other factors that may have impacted energy use at the site and the date(s) when these events occurred.

During the previous process evaluation,[4] Cadmus learned that the IOUs had defined data collection guidelines during the program design. This was done to align the efforts of the four IOUs and the five CEI advisors, ensuring that all required data were collected. As a result of this effort, we received all the required data. Also, all five CEI advisors provided similar data. Beyond the data required for evaluation, some CEI advisors provided analyses such as plots of energy usage over time, engineering savings estimates for O&M measures, and details from the energy audit.

Ability to Estimate Energy Savings

After determining that the provided data were complete, Cadmus assessed whether the data were sufficient for estimating energy savings. PG&E was able to provide daily billing and production data, while SCE/SCG provided monthly billing and production data. Billing and production data were not requested from SDG&E since both selected facilities were still in the planning stage.

During our recent impact evaluation of Bonneville Power Administration's Energy Management Pilot Program, we found that the interval of the data has a large impact on whether energy savings can be

[4] Cadmus. *Process Evaluation of California's Continuous Energy Improvement Pilot Program.* October 2012. Prepared for the California Investor Owned Utilities.

determined. In particular, we were more likely to detect energy savings at facilities that provided daily or weekly data than at those providing only monthly data.[5] Based on this experience, we recommended that the IOUs collect and provide daily interval billing and production data.

At three of the eight sites that had progressed to at least the implementation stage, Cadmus did not attempt to estimate energy savings because of insufficient data. In addition to having only monthly data, each of those three sites had less than a year's worth of data from the post period (after CEI was implemented). Specifically,

- One had 6 months of post-period data;
- One had 8 months of post-period data; and
- One had 11 months of post-period data, but only one project had been implemented.

As for the five sites for which Cadmus attempted to detect energy savings, all had one year or more of post-period data. However, one of these sites had also installed a large number of capital projects, both before and after implementing CEI. Due to the large number of capital projects in both the baseline and test periods, we were unable to establish baseline energy consumption and estimate energy savings at this facility. At another site, the regression analysis resulted in statistically significant negative savings, indicating an increase in energy consumption. A review of the site's documentation revealed that this facility underwent a renovation and expansion shortly after the facility enrolled in CEI.

Ability to Calculate Cost-Effectiveness

To determine whether cost-effectiveness could be calculated, Cadmus requested that the IOUs provide program administration costs and capital measure costs for the assessed facilities.

- SDG&E reported that, because it tracks program administration costs as a total, it could not separate out the costs for the two selected facilities. (We note that since cost-effectiveness at the program-level would be calculated during a full-scale impact evaluation, tracking administration costs at the program level is appropriate.) SDG&E also reported that one of the selected sites has since dropped out of the program, so it could not provide capital measure costs for that facility.

5 Cadmus. *Energy Smart Industrial - Energy Management Pilot Impact Evaluation.* February 2013. Prepared for Bonneville Power Administration. Available online: www.bpa.gov/energy/n/reports/evaluation/industrial/

- PG&E provided separate program administration costs for each of its two selected sites. One facility did not install any capital measures and, therefore, had no capital measure costs. The second facility installed eight capital measures, of which PG&E was able to report costs for four.
- SCG provided separate program administration costs for each of its six selected sites and for the capital measure costs at the facilities that installed gas measures. SCE did not provide data for the electricity measures and so we were unable to assess whether cost-effectiveness could be calculated.

Assessment of Energy Savings

In this section, Cadmus describes in detail the methodology used to calculate energy savings and discusses the facility-level results.

Estimation Methodology

To estimate the energy savings, Cadmus requested and reviewed the program documentation and data collected from each facility. We then developed a regression model to estimate each facility's energy savings. Finally, we estimated the savings based on consumption, production, weather, and program participation. Our estimation approach also accounted for savings from capital projects that were completed during the baseline and pilot test periods.

Overview of Pilot Sites

Cadmus evaluated the energy savings at four pilot sites, as listed in Table 3. Each site had its own pilot test period, which began on the day or in the month that the site representative signed the memorandum of understanding.

Table 3. Overview of Test Facility Characteristics

Site	Industry	Data Frequency	Test Period Date Range	CEI Start Date
PG&E 1	glass products manufacturer	daily	1/1/2008 – 8/31/2011	5/10/2010
PG&E 2	food processing plant	daily	7/1/2010 – 11/8/2012	7/1/2011
SCE/SCG 1	carpet manufacturer	monthly	1/2009 – 10/2012	11/2010
SCE/SCG 2	food processing plant	monthly	1/2009 – 10/2012	8/2011

PG&E 1 completed two rounds of CEI[6] and then disengaged from the program slightly more than a year after enrolling, reportedly being confident it could continue with CEI on its own. This facility did not have test period data available after the date PG&E 1 disengaged. SCE/SCG 2 underwent a facility renovation and expansion shortly after enrolling in CEI.

Modeling

To estimate the energy savings at each of the four sites, Cadmus conducted a regression analysis of interval meter data. The interval meter data contained at least one year of baseline period data and one year of test period data (although most sites included more data).[7]

[6] One round of CEI encompasses all six stages: commitment, assessment, planning, implementation, evaluation, and modification.

[7] Cadmus estimated a separate consumption model for each site, because each industrial site has unique factors influencing energy consumption and energy-use sensitivities with respect to output and weather. Furthermore, we did not develop a control group of industrial sites because of this uniqueness and the difficulty of acquiring energy use and output data for nonparticipants.

To estimate energy savings, we adopted an approach similar to one that we helped develop and that we have used successfully in similar projects. As described by Luneski,[8] this approach involved developing and estimating regression models of site energy use that reflected both the key attributes of the site ***and*** the availability of data. The approach was specifically intended to estimate energy savings from changes in both O&M and behavior (referred to together here as O&M) in industrial facilities.[9]

Regression analysis is appropriate for estimating savings from O&M changes for two main reasons:

- Because CEI may affect a variety of energy end uses, it may be more practical and cost-effective to measure savings at the site level rather than at the end-use level.
- As CEI savings are derived largely from multiple O&M changes over time, there are challenges to developing engineering savings estimates for each individual O&M measure.

The CEI advisors developed engineering savings estimates for most of the capital measures installed during the baseline and test periods. Cadmus used these estimates to control for energy savings from capital measures and to avoid double counting the savings. Avoiding double-counting is important because other IOU programs that provide incentives could claim savings from these measures.

Evaluation Estimation Approach

Cadmus estimated the O&M savings by measuring a site's energy consumption in the period before the O&M changes (the baseline period) and comparing it to its consumption in the period after the changes (the test period). Our savings estimates were based on weather, facility production, and other observable factors that can affect energy consumption (including some energy-efficiency capital measures).

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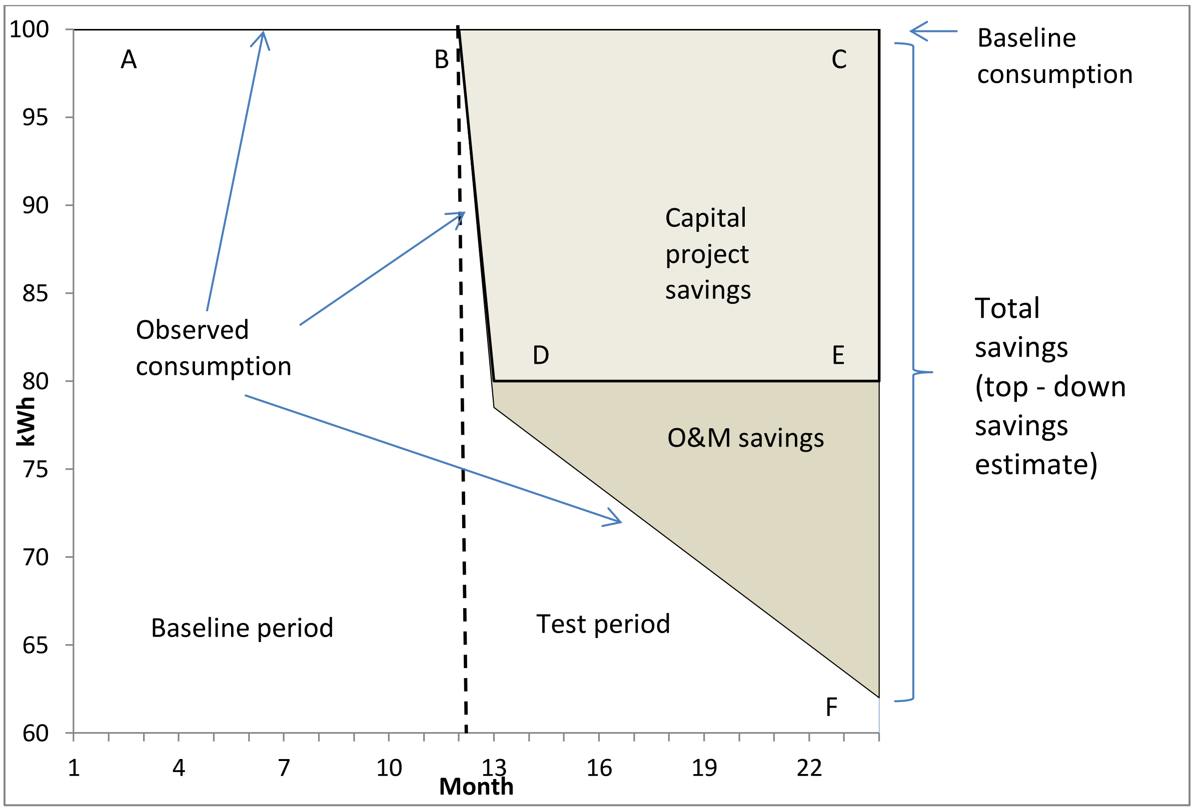
[8] Luneski, R.D. *A Generalized Method for Estimation of Industrial Energy Savings from Capital and Behavior Programs*. Industrial Energy Analysis, 2011. Available online: http://industrial-energy.lbl.gov/files/industrial-energy/active/1/A%20generalized%20method%20for%20estimation%20of%20industrial%20energy%20savings%20from%20capital%20and%20behavioral%20programs.pdf.

[9] This methodology was first applied to the Northwest Energy Efficiency Alliance's (NEEA) Continuous Energy Improvement Program. As the independent evaluator of this program, Cadmus assisted in developing this methodology. In particular, we significantly contributed to the development of the Intervention Trend model, and we reviewed the savings estimates for each participating facility.

Illustrating our approach, Figure 1 shows the monthly consumption for a hypothetical industrial facility.

- The vertical dashed line at month 12 indicates the start of the test period.
- The line connecting the points A, B, D, and F indicates observed consumption.
- The line segment connecting points D and F shows the facility's consumption after participating.
- The baseline consumption—or the amount of expected consumption without the measures—is shown by the line segment between B and C.

Figure 1. Illustration of Estimation Approach for a Single Site*



* O&M savings increase linearly over time in the figure. When estimating the models, Cadmus estimated the average monthly savings instead of the monthly trend in savings. If savings had an increasing trend, the evaluation estimate of average monthly savings would overstate the savings in the first months and understate the savings in the last months, but would equal the total *annual* savings.

The energy savings from participation in the CEI pilot program is the difference between the baseline consumption and the observed consumption. These savings are from O&M and capital measures.[10]

- The total energy savings are represented by the two gray sections of the figure, defined by points B, C, E, F, and D.
- Capital measures savings are represented by the light gray section of the figure defined by points B, C, E, and D. These savings can be determined by using engineering estimates or deemed savings values.
- O&M savings are represented by the dark gray section of the figure, defined by points D, E, and F.

Cadmus estimated the baseline consumption conditionally, based on output, weather, and other variables affecting energy use. We estimated the total savings as the difference between observed and reference consumption. O&M savings are the difference between total consumption and savings from capital measures.

Energy Savings Estimation

At each facility, Cadmus followed these eight steps to estimate the pilot O&M savings.

1. Collected billing, production, weather, and program participation data.

- The IOUs and CEI advisors provided billing, production, and program participation data (site characteristics and main drivers of energy use; capital measures and engineering savings estimates; and O&M energy management and other program activities).
- Cadmus obtained weather data from the National Oceanic and Atmospheric Administration's National Climatic Data Center.
- The energy billing and production data we obtained covered at least the year before and the year after the facility enrolled in CEI. Most facilities had more than two years' worth of billing and production data available, and the data ranged from January 2008 to November 2012.

2. Cleaned and prepared billing data and other explanatory variable data for analysis.

Cadmus checked the consumption and production data for missing observations and missing or erroneous values. We found that the data were generally clean, although a few sites had one or more missing observations. However, these observations were typically missing from production variables that were not used in the analysis, so their absence did not affect the analysis.

To identify outliers and to verify that the series were aligned correctly, we also plotted the billing and production data over time.

[10] Later in this chapter, we discuss how we accounted for capital measures in the baseline period.

To match weather data to the billing and production period, we located the weather station nearest each site and used daily temperature data to calculate the cooling degree days (CDD), heating degree days (HDD), and average daily temperature for the period.

In addition, we created indicator variables for any capital measures implemented before the start of the pilot test period *and* for any capital measures implemented during the test period that did not have available engineering savings estimates. For the periods after the measure was installed, we set these variables equal to 1; for the periods before the measure was installed, we set these variables to 0.

3. Identified the baseline period and test period.

The facility energy use during the baseline period (which occurred before the facility enrolled in CEI) represents what the energy consumption would have been had the facility not participated in the pilot. Cadmus determined the baseline period for each facility as the time before the customer signed the memorandum of understanding. The signing date marks a facility's enrollment in the CEI pilot program. For most sites, we received baseline period data for one to two years before CEI enrollment.

To estimate the total savings during the test period, we created indicator variables for the regression model, and the coefficients on these variables reflect both the O&M savings and capital measure savings.

4. Reviewed facility operations and production data.

To understand the drivers of energy use—such as facility production and weather—Cadmus reviewed the data, taking note of the different inputs, outputs, and production schedules. To the extent possible, we incorporated the information about these and other factors into the regression model.

We also plotted energy use against different measures of output, weather, and other independent variables. These bivariate plots of energy use and output helped to inform the functional relationships (linear, quadratic, log-linear, etc.) between energy use and the independent variables in the regression models. Then, to gauge the strength of the relationship between these variables, we plotted energy use and output against time.

5. Developed a regression model for the facility.

To establish a valid baseline in the test period, Cadmus developed a regression model of the energy consumption. We determined the regression specification using our understanding of the relationship between a site's energy use and its output, weather, and other drivers of energy use.

Our models controlled for output, weather (if energy use was weather-sensitive), the CEI participation period, and capital measures in the baseline period. Our models also controlled for capital measures when no engineering savings estimate was available from the test period.

A generic model of electricity use at a site is this:

$$\text{energy}_t = \alpha_0 + f(\mathbf{output}_t, \boldsymbol{\beta}) + g(\mathbf{weather}_t, \gamma) + \theta_1 \text{pilot\_test}_{1t} + \varepsilon_t \qquad \text{(eq. 1)}$$

Where the model variables are defined as follows:

energy_t	=	Electricity or gas use (or for a subset of metered end uses at the site) during period t.
$\textit{output}_t$	=	A vector of the amount of different outputs produced in period t. The model might contain several different outputs, and those outputs may enter the model non-linearly.
$\boldsymbol{\beta}$	=	A coefficient vector that defines the relationship between the outputs and energy use. In a linear model, this coefficient is the average energy use per unit of output.
$\mathbf{weather}_t$	=	A vector of weather indicators at the site during period t. This included HDDs, CDDs, or both, or it was the average daily temperature.
γ	=	A coefficient vector showing how energy use depends on weather.
pilot_test_{1t}	=	An indicator variable for whether period t was in the first year of the test period. This variable equaled 1 in the first year of the test period and 0 in all other periods.
θ_1	=	The average per-period pilot effect on consumption in the first year.
ε_t	=	The model error term representing unobservable influences on energy use in period t.

In this model, the pilot_test variables entered the regression equation linearly, implying that the pilot caused a level shift in energy use. An alternative specification would allow savings to depend on output or weather, determined by the types of energy uses targeted. We employed both approaches in modeling energy use, and the specification we ultimately used was determined by which energy end uses CEI targeted and the fit of the model.

Note that while developing the regression model specification, we experimented with different functional relationships between energy use, weather, and output. Our choice of a functional relationship was guided by: (1) the plots of output against the different model drivers, and (2) our knowledge of engineering relationships.

6. Estimated the model parameters and total energy savings.

We estimated the regression models by ordinary least squares (OLS) or by feasible generalized least squares (FGLS), selecting the final method based on whether there was evidence of autocorrelation conditional on the observed covariates. If the model did not account for autocorrelation, then the coefficients would be unbiased and consistent but the model standard errors and inferences based on the standard errors would be incorrect.

To test for autocorrelation, we plotted the residuals from OLS regressions and conducted Durbin-Watson tests. If there was autocorrelation (that is, if we could reject the hypothesis of no autocorrelation), we estimated the site regression model by FGLS.

7. Conducted robustness and sensitivity checks of the regression model.

We typically estimated between six and 15 regression model specifications. The model specifications were varied in the functional relationships between energy use and the energy use drivers, and they included (or excluded) different independent variables.

- We checked the signs and statistical significance of each model's estimated parameters, as well as checking the joint significance of some parameters.
- We rejected model specifications with parameters that were either statistically insignificant or had the wrong signs.
- We tested the robustness of the pilot_test coefficient by excluding or including different model variables.
- Finally, we considered each model's overall fit of the data using the adjusted R^2 statistic.

8. Estimated O&M savings using information about the capital measures' engineering savings values.

Cadmus' regression analysis yielded an estimate of the per-period (day, week, or month), first-year participation electricity or gas savings from O&M and test period capital measures. Using the regression result and the appropriate scaling factor, we estimated the annual savings and then subtracted the engineering estimate of the first year's capital measure savings to arrive at an estimate of the O&M savings (as shown in Figure 1).

We calculated 80% confidence intervals for each site's savings, which is the confidence level \recommended in the Northwest Power and Conservation Council's Regional Technical Forum guidelines for custom projects. In estimating the confidence intervals, we treated the engineering estimates of the capital measure savings as known and non-stochastic.

Facility-Level Savings Estimates

The point estimates for facility-level electricity savings are shown in Figure 2 and Table 4. Note that the two PG&E facilities did not install capital measures during the test period and, therefore, the O&M savings equal the total facility savings.

Figure 2. Total Annual Facility Electricity Savings as a Percent of Consumption

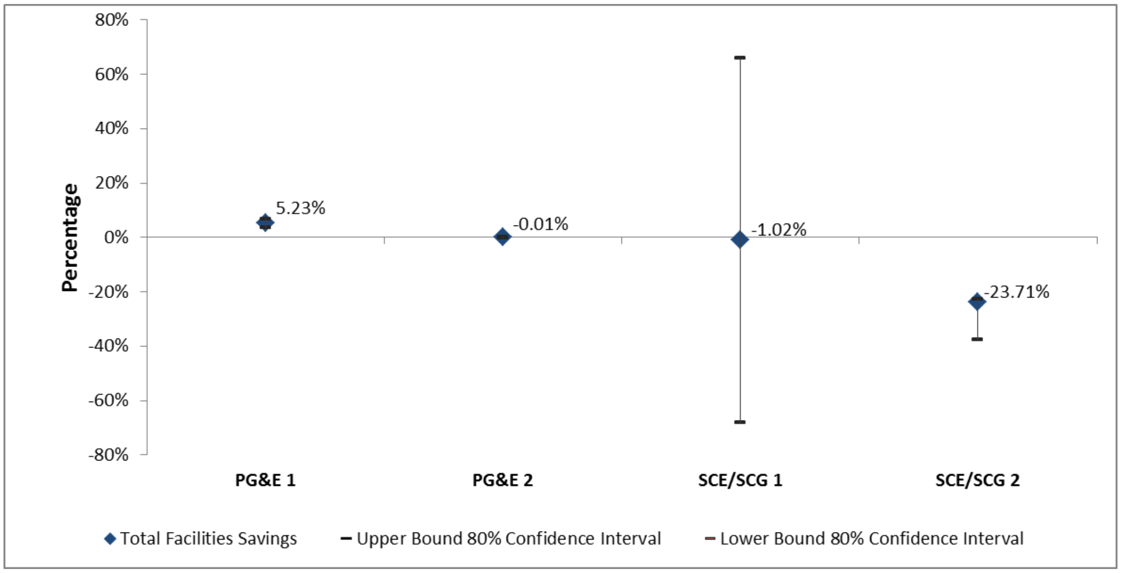


Table 4. Annual Electricity Savings by Facility

Site	Total Facility Savings (kWh/year)	80% Confidence Interval		O&M Savings (kWh/year)	O&M as a Percent of Load
		Lower Bound	Upper Bound		
PG&E 1	4,068,346	2,812,794	5,323,897	4,068,346	5.23%
PG&E 2	(146,908)	(1,357,999)	1,651,816	(146,908)	-0.01%
SCE/SCG 1	(58,082)	(3,885,199)	3,769,034	(114,269)	-2.00%
SCE/SCG 2	(985,344)	(1,563,292)	(937,182)	(1,195,788)	-28.78%

In summary, these are the results:

- SCE/SCG 2 underwent renovations shortly after beginning CEI, and this is the cause of the increase in electricity consumption.
- PG&E 1 had statistically significant and positive total facility savings. The percentage of O&M electricity savings were approximately 5%.
- The confidence intervals for PG&E 2 and SCE/SCG 1 include zero, indicating that the electric savings are not statistically different from zero. The energy savings point estimate for PG&E 2 accounted for -0.01% of baseline consumption. Holding everything else constant, it is more difficult to detect statistically significant savings at a facility with smaller savings as a percent of baseline consumption than at a facility with larger savings.

The gas savings at each facility as a percent of consumption are shown in Figure 3. Table 5 shows the total facility energy savings from both the capital improvements and the O&M measures. Note that the two PG&E facilities did not install capital measures during the test period and, therefore, the O&M savings equal the total facility savings.

Figure 3. Total Annual Facility Gas Savings as a Percent of Consumption

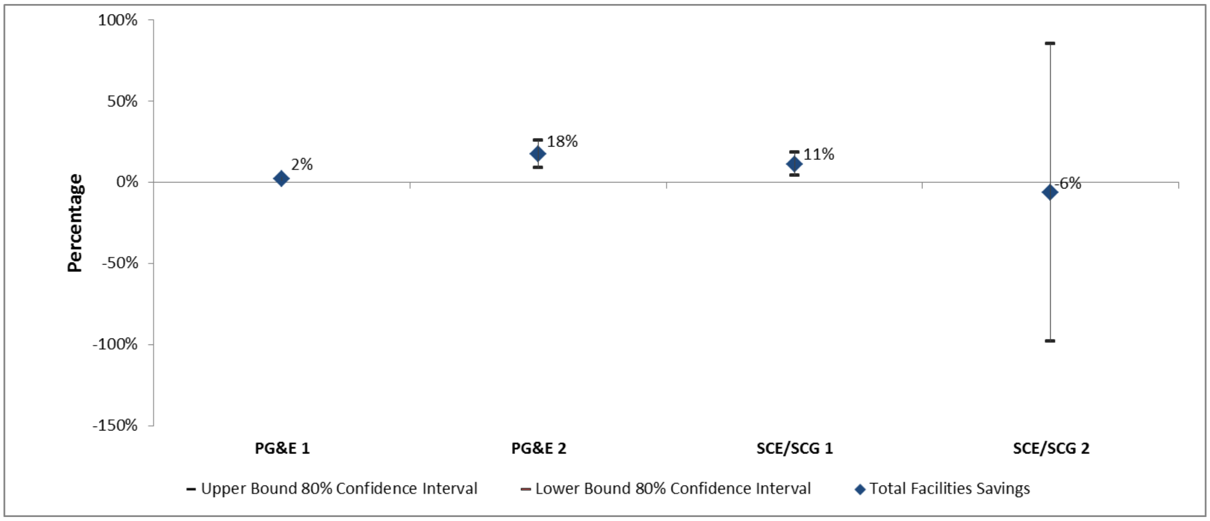


Table 5. Annual Gas Savings by Facility

Site	Total Facility Savings (therms/year)	80% Confidence Interval		O&M Savings (therms/year)	O&M as a Percent of Load
		Lower Bound	Upper Bound		
PG&E 1	335,181	146,808	523,553	335,181	2.26%
PG&E 2	1,406,121	737,622	2,074,620	1,406,121	17.64%
SCE/SCG 1	116,176	42,930	189,423	20,176	1.97%
SCE/SCG 2	(71,349)	(1,122,321)	979,623	(119,682)	-10.4%

In summary, these are the results:

- SCE/SCG 2 underwent renovations shortly after beginning CEI, and this is the cause of the increase in gas consumption.
- Both the PG&E sites and SCE/SCG 1 had statistically significant and positive O&M gas savings. The O&M gas savings as a percentage of baseline consumption were approximately 2% for PG&E 1 and 18% for PG&E 2. The percentage of savings of SCE/SCG 1 was 2%.

About Negative Savings Results

Although negative savings indicate an increase in energy use, they do not imply that the increase is a result of the CEI program. Negative savings could result from a number of possibilities, such as:

- The O&M changes were ineffective and had an opposite effect of what was intended.
- The engineering estimate of savings from capital measures in the test period was overestimated. Because O&M savings are estimated as the residual between total savings and capital measure savings, an overestimate will bias the O&M savings downward. If the estimate of capital measure savings is sufficiently high, the estimate of O&M savings will be negative.
- The data may not allow for an unbiased savings estimate. For example, there may have been unobserved or unaccounted for changes at the facility that caused consumption to increase during the test period. It is also possible that the O&M changes coincided with the installation of capital measures, making it difficult to separately identify the O&M savings.

Findings from Other Energy Management Programs

Cadmus used a methodology to calculate energy savings that is proven to be effective and accurate in evaluations of similar programs. From evaluations of other industrial and large commercial strategic energy management programs, an overview of the verified O&M electricity savings as a percentage of consumption are shown in Table 6. (Note that the gas savings from these programs were not available, or were only available for a small number of facilities, so those savings are not included because they may not represent a typical site.)

Table 6. Annual O&M Electric Savings Results from Other Strategic Energy Management Programs

Program	Year Program Started	Program Years Evaluated	Evaluation Test Size	Industry Types	Average Annual O&M Electric Savings as Percentage of Baseline Consumption
California's Continuous Energy Improvement Pilot	2010	2011-2012	3	Food Processing, Carpet Manufacturer, Glass Manufacturer	PG&E 1: 5.2% PG&E 2: -0.01% SCE 1: -2.0%
Northwest Energy Efficiency Alliance Industrial Initiative*	2004	2009*	18	Food Processing Plants	3.0%
Bonneville Power Administration Energy Management Pilot**	late 2009	2011-2012	16	Various	2.7%

* Cadmus. *NEEA Market Progress Evaluation Report #6: Evaluation of NEEA's Industrial Initiative.* January 28, 2011. Prepared for the Northwest Energy Efficiency Alliance. Available online: http://neea.org/docs/reports/Evaluation-of-NEEAs-Industrial-Initiative-639C6B786ECD2.pdf?sfvrsn=10. Note that there is an evaluation report of NEEA's program for the 2010 program year, but as it does not report savings as a percentage of consumption, it does not provide a basis for comparison.

** Cadmus. *Energy Smart Industrial - Energy Management Pilot Impact Evaluation.* February 2013. Prepared for Bonneville Power Administration. Available online: www.bpa.gov/energy/n/reports/evaluation/industrial/.

In general, facilities participating in strategic energy management programs realize approximately 3% electric savings from O&M measures during the year which the programs were evaluated. The results from California's CEI pilot program represent only three of the 39 sites enrolled in the program and are not representative of the program as a whole.

Cadmus also notes that this was a pilot program, so some CEI advisors may not have had previous direct experience with strategic energy management, although all had experience with energy audits and with assisting commercial and industrial customers with energy efficiency projects. We also note that two of the five CEI advisory firms were involved with NEEA's and BPA's programs listed in Table 6, and these firms advised more than half of the participants in California's CEI program. Thus, it is possible that these firms could achieve similar results with the participants in California.

As only three sites were evaluated in California's program, it is not possible to draw conclusions about the level of savings achieved by the pilot program. If the IOUs and stakeholders want to quantify the impact of the CEI pilot program, Cadmus recommends conducting a full impact evaluation of all of the facilities after they reached the evaluation stage.

The Benefit of Collecting Data at Frequent Intervals

During the evaluation of BPA's pilot program Cadmus found a relationship between the frequency of the energy consumption and production data and the ability to detect savings. O&M savings were detected at the 20% significance level at seven of the eight sites that provided daily or weekly data. In contrast, savings could only be detected at only two of the nine sites that provided monthly or bi-monthly data. [11] If a full impact evaluation is conducted for the pilot or a new CEI program, it is recommended that daily or weekly billing and production data be collected and used in the billing analysis.

[11] Cadmus. *Energy Smart Industrial - Energy Management Pilot Impact Evaluation.* February 2013. Prepared for Bonneville Power Administration. Available online: www.bpa.gov/energy/n/reports/evaluation/industrial/.

Cost-Effectiveness Analysis

Cadmus was able to calculate energy savings for four facilities; however, the lack of sufficient data, as previously mentioned, prevented Cadmus from calculating cost-effectiveness. Additionally, as we were only able to determine the amount of energy savings at three facilities, we anticipate that the cost-effectiveness results are not likely to be representative of the pilot program.

Review of Program Performance Metrics

These program performance metrics (PPMs) were established by the IOUs and CPUC for the CEI pilot:

1. The number and percentage of commercial, industrial, and agricultural CEI participants meeting short-term (2010–2012) milestones, as identified through their long-term energy plans.
2. Development of lessons learned, best practices, and plans to ramp up the CEI program.
3. The number and percentage of commercial, industrial, and agricultural customers who created an energy plan through participation in CEI.

During the process evaluation of the CEI pilot program conducted in 2012,[12] Cadmus reviewed the PPMs and recommended several additional PPMs for a full-scale CEI program. Because the second metric was specific to the pilot program, we recommended excluding that metric. We proposed keeping the first and third metrics listed above and adding these six metrics:

1. Annual energy savings goals by sector, expressed as a percentage of the baseline energy consumption for participants within that sector.
2. The number and percentage of participants graduating from CEI and continuing to practice energy management.
3. The number and percentage of participants leveraging incentives or services from other IOU programs.
4. The number of energy manager training attendees, tracked by sectors.
5. The percentage of facilities within each sector adopting CEI on their own. This category includes both companies enrolled in the program and applying CEI concepts at other facility locations, ***and*** those nonparticipating companies implementing CEI practices on their own.
6. Participant satisfaction in these three areas (at a minimum): (a) with the program overall, (b) with the CEI advisor, and (c) with the energy savings achieved.

We also recommend an additional metric for consideration: The number and percentage of participants who are tracking their energy consumption and quantifying their energy savings. We recommend this last metric because facilities that are able to track their energy consumption and quantify energy savings will see the direct impacts of their efforts, which will motivate them to continue practicing CEI.

[12] Cadmus. *Process Evaluation of California's Continuous Energy Improvement Pilot Program.* October 2012. Prepared for the California Investor Owned Utilities.

Conclusions and Recommendations

We assessed the evaluability of the CEI pilot program for data completeness and the ability to calculate energy savings using a regression analysis.

Data Completeness

Cadmus received all of the data needed for assessing the energy savings, except capital measure cost required for calculating cost-effectiveness. All five CEI advisors collected the relevant data and all provided similar data; it was apparent that they followed the IOUs' data collection guidelines.

Recommendations:

- The CEI advisors should continue following the data collection guidelines developed by the IOUs.
- The IOUs and CEI advisors should collect the installed cost for capital measures so that cost-effectiveness can be calculated.

Ability to Calculate Energy Savings

Based on the results of this and other studies of CEI programs, regression analysis provides a reasonably reliable method for estimating the impacts, subject to several considerations, most importantly availability and completeness of data.

Conclusions for the Four Facilities That Were *Not* Modeled

Although all of the relevant data were collected for calculating energy savings, we were unable to detect savings at four of the eight facilities that had entered the implementation stage. The monthly production and billing data for three of these four facilities did not have enough observations for the post-implementation period to provide an adequate basis for estimating the regression models. The fourth facility had installed a large number of capital projects both before and after implementing CEI, making it difficult to establish a reliable baseline for estimating O&M energy saving impacts.

Recommendations:

- **Conduct the impact evaluation after two years.** For a future CEI program, the impact evaluation should be conducted after facilities have participated for two years. This will provide enough time for all facilities in the program to have their CEI plan in place and to have implemented projects and will provide sufficient post-implementation period data.
- **Perform a statistical power analysis before enrolling a facility in the CEI program.** A statistical power analysis (or fractional savings analysis) would yield an *ex ante* **probability** of detecting a site's energy savings with the available data. When beginning an engagement with a site, we recommend that the CEI advisor perform such an analysis. The analysis would require assumptions for each site about the significance levels (e.g., 20%), expected percentage of savings, the coefficient of variation (CV) of energy use, the correlation between baseline and test period energy use, and the number of baseline and test period observations. The IOUs could use energy use data in the baseline period to develop assumptions about the site CV and

correlations. Then, the IOUs could use the statistical power analysis to determine whether the baseline and test periods are sufficiently long (i.e., the number of days, weeks, or months) for detecting savings. If the analysis shows a low probability of detecting savings, then the facility should be required to collect data for a longer period or more frequently (e.g., daily instead of monthly) in order to participate in the program.

- **Extend the length of the baseline period.** It can be difficult to establish a baseline at facilities that install capital and O&M measures during the baseline period, especially if these projects occur two to three months before implementing CEI. Providing an additional year of baseline data for these facilities could improve the regression estimates.

Conclusions for the Four Modeled Facilities

One of the four sites where we estimated energy savings underwent a facility renovation shortly after beginning CEI, which caused an increase in electricity and gas consumption that was not representative of program impacts.

The energy savings results for the remaining three sites were as follows:

- PG&E 1: Electricity savings were 4,068 MWh per year, representing 5.2% of baseline electricity consumption. Gas savings were 0.34 million therms per year, accounting for 2.3% of baseline gas consumption.
- PG&E 2: Electricity savings were not statistically different from zero. Gas savings were 1.406 million therms per year, accounting for 17.6% of baseline gas consumption.
- SCE/SCG 1: Electricity savings were not statistically different from zero. Gas savings were 0.116 million therms per year, accounting for 2.0% of baseline gas consumption.

Cadmus encountered these challenges in attempting to detect energy savings for the remaining four pilot program participants.

- ***Timing of Measure Implementations.*** The energy savings for O&M measures installed near the end of a program year may not be estimated precisely, due to the lack of sufficient post-implementation data.
- ***Other Events at the Facility Can Confound the Analysis.*** As our experience with one facility showed, CEI impacts will be difficult, if not impossible, to detect in facilities that undergo major renovation and/or expansion shortly after enrolling in CEI. These changes will potentially lead to large increases in the facility's energy use and are hard to control for in the regression analysis. This is especially the case where the project lacks sufficient post-CEI and pre-renovation billing and production data.
- ***Large Confidence Intervals around Results.*** The 80% confidence intervals for the energy savings were large, reflecting significant uncertainty around the precision of the estimates. In our judgment, the statistical performance of the results would improve with longer pre- and post-CEI data or with higher frequency (daily or weekly) billing and production data.

Recommendations:

- **Collect billing and production data at higher frequencies.** When estimating energy savings with regression, the probability of detecting savings increases with higher data frequency. Savings are more likely to be detected with daily or weekly data than monthly data. Also, the confidence intervals are likely to be smaller with daily or weekly data than monthly data. The statistical power analysis mentioned above will provide guidance as to what data interval is most appropriate for a site. If a site shows a high correlation between energy consumption and production and weather variables, then monthly data may be sufficient.
- **Provide engineering calculations for capital measure savings.** When modeling the O&M measure savings, one method to account for the capital measure savings is to adjust electricity consumption upward to account for the lower energy use caused by the measure's implementation. This adjustment is most useful when capital measures have been installed in the same period as O&M measures and their impacts are not seasonal. The IOUs could aid the evaluation by providing the *ex ante* saving calculations, especially where the measures were installed under an IOU-sponsored program.
- **Track large facility events during enrollment.** If a facility has planned for any large events outside of CEI that impact energy use, such as renovations or major changes to plant operations, they should not be eligible for the CEI program as it will not be possible to estimate energy savings. Facilities that implement these types of projects after participating in CEI should be required to inform their CEI advisor and IOU, who would then decide whether the facility would be eligible to continue in the program, or would be a more appropriate participant in another program. It may be possible for a facility to temporarily suspend participation in the CEI program while renovations or other non-CEI changes are taking place - and to continue with CEI later.
- **Consider metering capital projects.** In some instances where both capital and O&M measures are implemented within a short period of time, metering the impacts of capital project(s) should be considered if the IOUs would like to report capital savings separately from O&M savings. Applying regression analysis to measure savings from O&M requires that the savings from O&M and any capital measures be sufficiently independent (uncorrelated). An overlap between implementation of capital and O&M measures will make it difficult to estimate their separate impacts.

Other Considerations

Reporting Energy Savings Results

In estimating the savings attributable to CEI, it is important to account for a facility's participation in other IOU-sponsored programs. The documentation must identify measures that received incentives through other programs. The savings associated with these measures can then be properly accounted for when estimating the CEI impacts.

The CEI plan documents measures that were recommended by (and originated in) the CEI program. For example, a building that installed a new HVAC system recommended by the CEI program may have received an incentive for this equipment through a different program, and that program may have claimed those savings. However, these savings should be acknowledged so that the full value of the CEI program is recognized.

Therefore, Cadmus recommends reporting electric and gas savings for three scenarios:

- Total savings (which encompasses all implemented measures);
- Savings attributable to CEI (which is calculated by subtracting the savings for measures incented by other programs from the total savings); and
- Savings that originated with CEI (which is calculated by subtracting the savings for measures that did not originate as a CEI program recommendation from the total savings.)

Determining Free-Ridership and Spillover

To assess free-ridership, it will be necessary to review documentation and interview facility staff about individual measures. This is because the best candidates for CEI are those facilities that were already interested in energy efficiency and likely to take some actions on their own. These candidates are more likely to receive management support to devote staff time to energy management. Therefore, many facilities are likely to be at least partial free-riders. However, the CEI program will encourage facilities to go beyond what they would have done on their own. It is therefore necessary to ask about individual measures to find out what projects the facility was already planning to implement on its own and what projects were motivated or accelerated due to participation in the CEI program. Participant spillover will be captured qualitatively in the facility's documentation of implemented projects and quantitatively with the regression analysis result for total facility energy savings.

To assess non-participant spillover, Cadmus recommends conducting non-participant surveys that ask questions about the extent of implementation of each CEI element. The survey results would show what percent of non-participating facilities have fully implemented CEI on their own or with assistance from outside the CEI program. In addition, the survey results would provide the IOUs with useful information about what facilities are doing on their own and what CEI elements facilities need assistance with.

Determining Persistence

The IOUs goal with the CEI program is to provide information and education to encourage facilities to manage their energy consumption on their own. However, this type of training program is new, and there has been little research to determine the persistence of behavior changes brought about by the CEI program. The intent of the IOUs' program is for facilities to incorporate CEI into their culture, so we recommend that, to the extent possible, the IOUs continue to collect data after a facility disengages with CEI. Measuring persistence would inform the measure lives used for projects in the cost-effectiveness analysis.

Persistence of CEI may be assessed using either quantitative or qualitative approaches. If the IOUs wish to quantify the persistence of energy savings from CEI, then production data should be collected. This information, along with the billing data, can then be used to measure energy savings and to quantify CEI persistence. Alternatively, persistence may be assessed qualitatively through periodic interviews with the facilities that have graduated from the CEI program to gather information on energy use behaviors and CEI-related practices.