IMPACT EVALUATION OF THE CALIFORNIA STATEWIDE BUILDING OPERATOR CERTIFICATION PROGRAM

Final

Prepared for:

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1. Executive Summary

The Building Operator Certification (BOC) program is a series of classes offered through California's Statewide Workforce Education and Training program. It provides in-depth and hands-on experience to professionals in the building operations and maintenance (O&M) field, with the goal of training professionals so they build skills that enable them, or others in their company, to reduce energy use in their commercial facility or facilities.

To date, the California Investor-Owned Utilities (IOUs) have implemented this program as a non-resource program, which means that the savings from this program are not counted directly in the energy-savings claims by the utilities. However, with IOUs and Commission staff have been discussing, the possibility of the Commission transitioning this to a resource program sometime in the future." These discussions are due, in part, to the fact that past studies have documented large quantities of savings that occur as a result of California's Workforce Education and Training program efforts. To date, however, estimates of these savings have not met the required level of rigor needed to ensure that savings can be claimed.

This evaluation effort sought **to better understand savings and whether there are methods that would allow for a higher level of rigor when estimating savings from training programs**. Specifically, the BOC program (or series of courses) was looked at as a case study for possible future opportunities to document savings and develop information that could be used in an ex ante work paper process.

Unlike rebate programs, this course does not have a database of the measures installed by participants. Because it is a training effort, participants are taught about various equipment, measures, and operations that can save them energy in their facilities, but the program does not record energy-saving actions taken as a result of the BOC program. This makes estimating energy savings as a result of the program challenging. In total, the course teaches students about 103 different actions (measures, operations and maintenance procedures), and because of the heterogeneity of the measures and the pre-existing equipment in each facility, it is difficult to accurately determine program-wide savings.

In order to overcome the measurement obstacles our study needed a multi-step process built upon existing program databases and course information. We interviewed participants through a mixed-mode effort, and supplemented this with site visits. These efforts allowed us to first understand who was taking action, what actions were being taken and then estimate the energy savings from these actions.

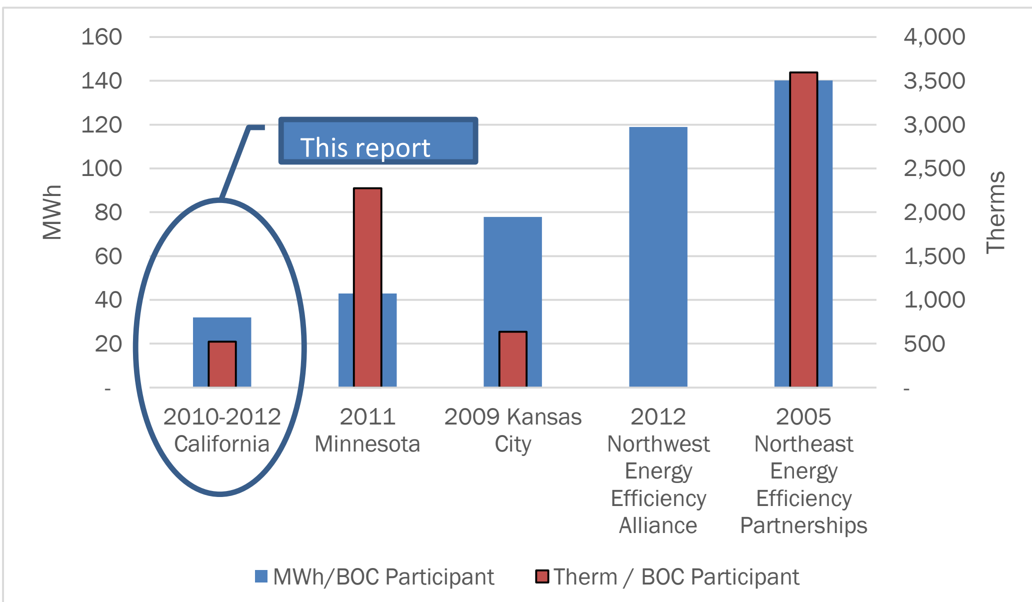
Overall, the findings from our study are as follows:

- 80% of all BOC program participants who become BOC certified are in a position to save energy, because they directly manage a facility or conduct maintenance operations. The large majority of participants, therefore, are the correct target for the BOC program because they are in a position to start saving energy for a specific facility. Other participants included, students, unemployed, some have switched careers since the training and some are in other maintenance-related positions such as plumbers.

- Participant comments and responses demonstrated the value of the BOC program with more than half (58%) of participants stating that they took some energy-saving action post-program.

- In total, 543 people participated in the BOC program and received certification for building operation between 2010 and 2012. The savings from these participants' facilities totaled approximately 17.4 GWh, 2.43 MW, and 285,000 therms in net impacts per year.
  - The BOC program, therefore, resulted in an average per-student net savings of 32 MWh/year, 4.5 kW/year, and 525 therms/year.
  - The most frequent actions taken included lighting measures (most commonly sensors, replacing linear fluorescents with T8's and incandescents with CFLs), HVAC equipment scheduling, and fan optimization/air distribution actions.
- The estimated impacts from this program are in the middle of what other evaluations have found for therms, and lower than three of the other four reports in terms of electric energy savings. There may be several factors contributing to the difference in savings across jurisdictions. Among them, this study incorporated on-site visits to verify the actions taken and quantify savings while most other studies mainly relied upon self-reported surveys. Further, savings in CA may generally be lower given that CA's climate is more temperate than other jurisdictions.

Figure 1. Comparison of California Impacts with Other BOC Program Impact Reports



- We found minimal channeling between the BOC program and IOU energy efficiency rebate programs, which was surprising given that part of the training is dedicated to making participants aware of IOU rebate programs. Only 12 of 392 actions taken by BOC respondents (3.1%) were also found in the database of 2010-2012 Energy Efficiency paid measures. We removed these measures prior to gross impacts so do not double-count them. However, if left in, they would account for an additional 11% of MWh, 12% of MW, and 8% of kTherm impacts. This somewhat disproportionate savings is because half of the incented measures were lighting where the savings per measure is highest. If this minimal amount of channeling is true then the BOC program may be inducing more direct savings that are not accounted for in other programs than previously thought.

- In addition to documented saving opportunities, several parts of our study pointed to additional energy savings that could not be quantified. These indicators of additional savings include the following:
    - There were sites where we could not document savings due to security issues (government or military restrictions) or lack of time and resources on the part of the building staff. As such, our savings among the analyzed group is underestimated.
    - Non-respondents were more likely to work in multiple facilities, so if these individuals also realized savings, the potential for savings could be greater. As such, our savings may be underestimated.
    - It often takes time to implement projects or install equipment that could save a facility energy. Our study only examined a three-year period. Additionally, through conversations with facility managers, we recognize that further savings will occur following our efforts. As such, our savings values are most likely underestimated.

Our approach was able to document savings for the BOC program. The rigor of our approach was higher than in prior studies conducted for the BOC program in other parts of the country, but there are still limitations to our study. Key methodological findings from this study include the following.

- Past efforts to estimate energy savings for BOC in other parts of the country relied largely on survey efforts without on-site verification. Our results indicate that surveys alone do not provide a sufficient level of rigor to allow the program to build a database of actions from which to calculate savings. Frequently, we found that the measures reported from survey results were not installed as reported—just over one-third of measures claimed from survey results were actually verified as implemented. And when we went onsite, we found other newly installed energy-saving measures that had not been reported in the surveys.
- Savings found in this research most likely are representative of actions taken after the BOC program and, unless the trainings change dramatically, could be transferable to participants who become certified in future trainings. Applying savings only to certified participants is important because not all participants in the courses complete all courses and become certified.
    - The research is based on three years of participants across various sectors. Savings came from both equipment purchases and O&M actions across the spectrum of measures upon which the building operators were trained.
    - While we expect that there would be some savings variation given the possible population of participants trained and their ability to affect change within the buildings they oversee, the values in our research are similar (albeit lower) than findings in other evaluations. While those other evaluations (from research between 2005 and 2012) used only surveys and secondary data for estimating savings, the fact that our findings are closely aligned points to actions taken by BOC program participants that are not very different across time.
- The research for BOC program savings is grounded in primary data collection at the sites, but due to budget, savings are not calibrated by site energy use. As such, while savings are reasonable, the methodology may be less rigorous than desired by those involved in the workpaper process. However, some consideration should be given to whether gaining greater precision for this program is feasible given the nature of the program, the wide variety of actions that each participant could take and the wide variety of facilities they oversee.

- The analytical approach for determining net savings, while obtaining values comparable to resource-acquisition programs, is limited by the magnitude and heterogeneity of possible actions taken. A self-report approach that we chose to use is most likely the only viable method for this program.[1] However, the typical battery of self-report free ridership questions within California are not feasible, even if desired. As such, our approach uses an alternate questions with values that apply to broad categories of measures.

[1] Quasi-experimental approaches to obtain net savings that use comparison groups would suffer from lack of matched groups and an inability to tease out actions taken at sites that have no relationship to the information gained during the BOC program.

2. Introduction

The Building Operator Certification (BOC) program is a series of classes offered through California's Statewide Workforce Education and Training program. To date, the California Investor-Owned Utilities (IOUs) have implemented the BOC program as a non-resource program, which means that the savings from this program are not counted directly in the energy-savings claims by the utilities. The IOUs and the California Public Utilities Commission (CPUC), however, have discussed the viability of including the Workforce Education and Training program as a resource-acquisition program sometime in the future.

Based on a review of past studies across the country, BOC program kWh savings ranged from 0.02 kWh to 0.72 kWh per square-foot, and for those BOC programs that calculated it, gas savings ranged from less than 0.01 to 0.02 therms per square-foot.[2] However, these efforts often relied on self-reported survey data and engineering calculations to estimate savings. These prior estimates of savings have not met the required level of rigor needed to ensure that the savings from this program are comparable to savings from other programs run by the IOUs. Therefore, even though past studies across the country have documented energy savings as a result of the BOC program, the evaluation methodologies used have not met the required level of rigor needed to ensure that the savings are reliable enough to be claimed in California.

This research was done **to better understand savings, and whether there are methods that would allow for a higher level of rigor when estimating savings from training programs**. Our research occurred through a two-part research study that included a scoping phase, which was completed in January 2013 (see Appendix G). The initial phase was followed by this study, which sought to gather data through both interviews and site visits to facilities. The specific research questions that we sought to answer are described below.

2.1 Evaluation Research Questions

The five specific research questions answered within this evaluation are:

1. What are the baseline O&M practices that BOC program participants employ in their facilities, and what energy-efficient equipment was in place prior to participation in the program?
2. What are the gross annual energy (kWh and therm) and peak demand (kW) savings from participating facilities?
    a. What are the gross energy-savings impacts per participant? Per square-foot? Per series? Per site address (or company)?
    b. Which actions are most frequently taken by BOC program participants? Which of these actions results in the highest energy savings?
3. What amount of channeling occurs from the BOC program to the IOU's energy efficiency rebate programs, and how much energy savings is attributable to the BOC program (i.e., what is double-counted)?

[2] BOC Evaluation Plan_2013-02-20.doc created by Opinion Dynamics.

4. What are the net energy-savings impacts due to participation in the program?
    a. To what degree has the program influenced participants' decisions to install energy-efficient equipment or take O&M actions?
5. What is the persistence of energy-saving actions over time? [Initially desired but not quantified in this study due to project budget and timing constraints]

2.2 Description of the 2010-2012 Building Operator Certification Program

The Building Operator Certification (BOC) program is a nationally recognized energy efficiency training and certification program founded on the principle that trained and motivated operators can significantly reduce energy consumption. The BOC program, funded by the California Investor-Owned Utilities (IOUs) and administered by the Northwest Energy Efficiency Council (NEEC), provides in-depth and hands-on experience to professionals in the building operations and maintenance (O&M) field.

NEEC, extending efforts initiated by the Washington State Energy Office and the Idaho Building Operators Association, developed the Building Operator Certification program for the Northwest Energy Efficiency Alliance (NEEA) in 1997. The California utilities contract directly with NEEC for administration of the program as a statewide, coordinated initiative in California. The contracts specify the number of courses offered annually, and the number of participants registering for training.

The BOC program combines classroom training, exams, and in-facility project assignments to train and certify building engineers and O&M technicians in the practice of energy-efficient building operations and management. The program provides two levels of training and certification, both of which are designed to improve job skills and lead to improved comfort and energy efficiency at the participant's facility or facilities. The Level I course series focuses on expanding knowledge of building systems equipment and best practices for their efficient operation, while Level II students gain experience in preventative equipment maintenance and targeted training.[3]

The targeted program participants are medium and large commercial end-users who seek certification and who value the importance of efficient building technologies, particularly building engineers and O&M technicians. IOU program funding does not cover 100% of the cost of certification; the balance of the required funding ($1,395 for California residents, $1,595 for non-residents) is contributed by the participant's employer, with a discounted fee offered for each additional employee ($995 or $1,395 for residents or non-residents, respectively) who attends beyond the first employee.

To remain certified, a building operator must accumulate five re-certification hours per year for Level I, and 10 hours per year for Level II. Building operators may obtain these hours by providing NEEC with documentation of completion of qualified activities, including extended learning courses that NEEC has approved as qualifying for this requirement; technical webinars provided on the BOC program website; or completion of special projects to improve facility operation, maintenance, and/or energy efficiency.

[3] This description is according to the BOC program website http://www.theboc.info/w-value-benefits.html.

2.2.1 Curriculum and Courses Offered

BOC training consists of three components: Level I certification, Level II certification, and continuing education. Level I is a series of classroom courses that provides an overview of critical building systems. BOC Level I training consists of seven courses and covers topics related to energy transfer, air movement, heating systems and maintenance, motors, cooling, ventilation and control systems, lighting, electrical safety, environmental health, and safety and indoor air quality. One course is held per month and each is structured to allow for lecture, work in small groups, building tours, the completion of tests and assignments, and the performance of work at one's own facility.

Core curriculum courses must be completed to earn certification. In each region, the program manager may choose one of a suite of supplemental courses to add to that program year based on the needs of the region. This allows flexibility across the many geographical areas where the BOC program is offered.

Level II is a subsequent series of classroom courses that emphasizes preventative maintenance and more-targeted training. To remain certified, a building operator must accumulate re-certification hours. As stated previously, five hours per year are required for Level I, and 10 hours per year for Level II. Various national and regional organizations offer continuing education courses that are applicable to annual BOC certification renewal. As part of the continuing education, the BOC program provides both live and recorded technical webinars that count toward continuing education credits.

The certification and renewal processes are all managed by NEEC on behalf of the IOUs. The requirement for continued education provides the BOC program with an opportunity to direct students to course offerings at the Energy Centers, which count toward continuing education hour requirements.[4]

Table 1 below lists the curriculum for the BOC program.

Table 1. Level I and II BOC Program Curriculum

Course Name
Level I
BOC 101: Building Systems Overview
BOC 102: Energy Conservation Techniques
BOC 103: HVAC Systems and Controls
BOC 104: Efficient Lighting Fundamentals
BOC 105: O&M Practices for Sustainable Buildings
BOC 106: Indoor Environmental Quality

[4] Interviews with BOC program staff, January 2009.

Course Name
BOC 107: Facility Electrical Systems
Level II
BOC 201: Preventative Maintenance and Troubleshooting Principles
BOC 202: Advanced Electrical Systems Diagnostics
BOC 203: HVAC Systems Troubleshooting & Maintenance
BOC 204: HVAC Controls & Optimization
Level II Supplemental Courses (2 Offered per Course Series)
BOC 210: Advanced Indoor Air Quality
BOC 211: Motors in Facilities
BOC 212: Water Efficiency for Building Operators
BOC 213: Mastering the Fundamentals of Electric Control Circuits
BOC 214: Introduction to Building Commissioning
BOC 215: Electric Motor Management
BOC 216: Enhanced Automation and Demand Reduction
BOC 217: Environmental Health and Safety Regulations

BOC courses continually change over time based on feedback from instructors and IOUs, but 2012 saw a more significant change. The bulk of the new content was two core classes: *"BOC 1004: HVAC Controls Fundamentals"* and "*BOC 1006: Common Opportunities for Low-Cost Operational Improvement*." In addition, the course "*Facility Electrical Systems*" was removed from the core class lists and is now supplemental. In 2012, the new curriculum was implemented in San Ramon, Ontario, and Long Beach, California. The new courses will be offered in 2013 to all participants who began their certification program in the fall of 2012. These changes do not affect our methodology. Table 2 below lists this revised curriculum.

Table 2. Level I Revised BOC Program Curriculum

Course Name
Level I
BOC 1001: Energy-Efficient Operation of Building HVAC Systems
BOC 1002: Measuring and Benchmarking Energy Performance
BOC 1003: Efficient Lighting Fundamentals

Course Name
BOC 1004: HVAC Controls Fundamentals
BOC 1005: Indoor Environmental Quality
BOC 1006: Common Opportunities for Low-Cost Operational Improvement
Level I Supplemental (1 Offered per Course Series)
BOC 1007: Facility Electrical Systems
BOC 1008: Operation & Maintenance Practices for Sustainable Buildings
BOC 1009: Building Scoping for Operational Improvement
BOC 1010: EE Ventilation Strategies and High-Performance Heating and Cooling Equipment
BOC 1011: EEE Ventilation Strategies and Energy Savings through Energy Recovery
BOC 1012: High-Performance HVAC and Energy Savings through Energy Recovery

In addition to attending classes and passing all tests, students must complete a series of facility-specific projects.[5] Level I projects include five activities: developing a floor plan of the HVAC system components, an energy performance score for the building using ENERGY STAR® portfolio manager, a utility incentive calculation for a lighting project, a review of HVAC operations and maintenance procedures, and a lighting survey. For Level II students, projects require them to describe a power quality upgrade plan for their facility (or a part of it), compare original HVAC design and operating conditions to current conditions at the facility, and create an AC controls diagram as well as a maintenance checklist for the facility fan system.

2.3 Evaluation Report Layout

We provide an overview of our methodology first, followed by the gross and net impacts. There are several appendices that give detailed information about onsite audits as well as our data collection instruments.

3. Methodology

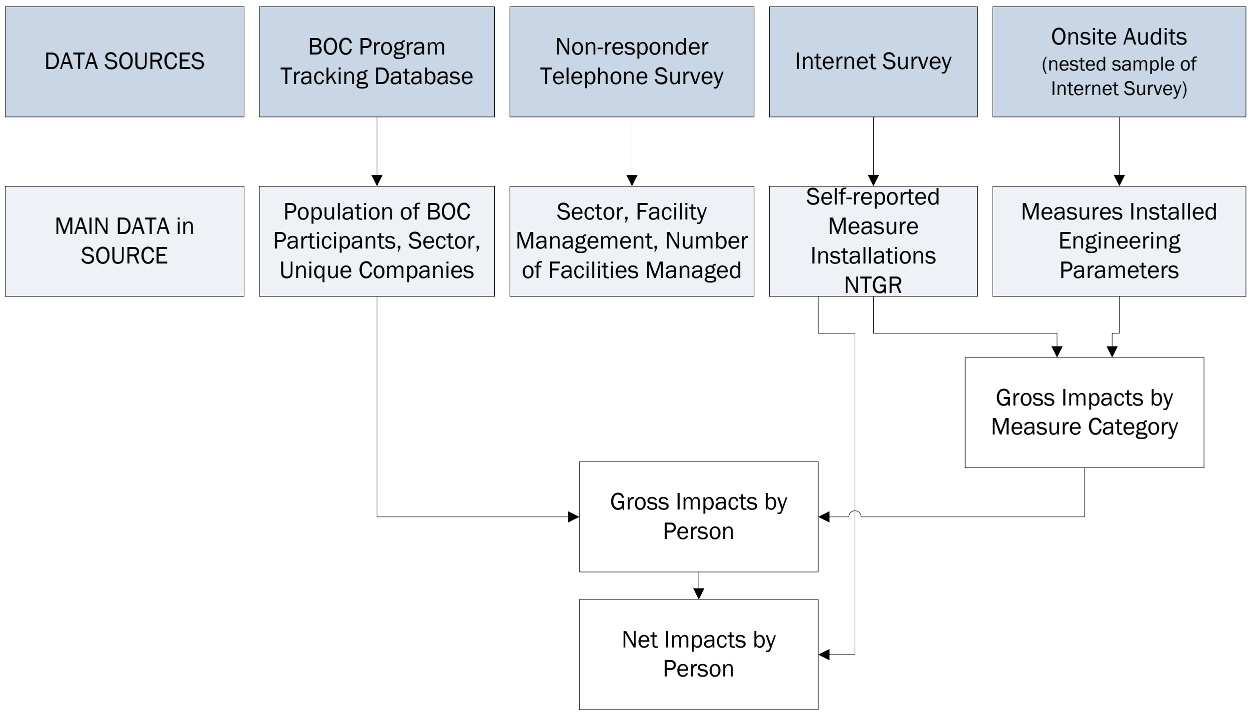
The evaluation team determined gross and net impacts by collecting primary data from participants through two efforts: an Internet survey and onsite audits. Calculations of gross impacts are based on an engineering approach, combining information from the sites and secondary data. Net-to-gross ratios (NTGRs) are derived from participant responses within the Internet survey, and the weighted average NTGR is applied to gross impacts to obtain net impacts.

Our Internet survey took place from May to June 2013, and data collection for onsite audits occurred from August through the first week of September 2013. Figure 2 presents a graphic representation of

[5] NEEC does not currently collect data from these class projects. In our Phase I effort, we proposed that they do so for future impact and process efforts.

the method, including the four data sources we used, and where the data for the gross and net impacts came from.

Figure 2. Overarching BOC Research



Details about the overall methodology and results from each of these data collection efforts are presented below.

3.1 Gross Impacts

We determined gross impacts through four main evaluation tasks:

1. Fielding of an Internet survey to all 543 BOC program participants who completed Level 1 and/or Level 2 courses and were confirmed to have received BOC certification based on NEEC's records. The 543 participants were employed at 236 unique companies. The respondents of the Internet survey represented 67 of those unique companies and 259 of the 543 participants (48% of all participants).

2. Applying primary and secondary data gathered for a nested sample of onsite audits to calculate average energy and demand savings by measure for measure categories (i.e., lighting, boilers, etc.). We removed savings from any measures already incented within the 2010-2012 period.[6] Measures in the nested sample represented 36% of all measures stated to have been installed in the Internet survey. The nested sample is a sample of a sample, a sample of participants

[6] We worked closely with Itron to obtain lists of all measures incented during the 2010-2012 period.

answered the internet survey and then a sample of them said they took action and agreed to a site visit.

3. Extrapolating the average energy and demand savings from this nested sample of onsite audits to all 1,138 measures in the Internet survey, and calculating an average per-person savings for all BOC program participants covered by the Internet survey.

4. Extrapolating the energy and demand savings from the companies represented in the Internet survey to the population of participants.

Table 3 shows the population and sample sizes within this research, and each activity is detailed next.

Table 3. Population and Sample Sizes

Metric	Unique Companies		People	
	Number	Percent of Population	Number	Percent of Population
Population	236	100%	543	100%
Completed Survey	67	28%	77	14%
All BOC Program Participants within the 67 Unique Companies Completing the Survey			259	48%
Completed Survey and Stated to Have Taken Action	43	18%	48	9%
Onsite Audits	14	33%[a]	15	31%[a]

[a] This is the percent of those who completed a survey and stated they took action.

3.1.1 Internet Survey

The BOC program participant survey effort consisted of two separate efforts: an internet survey census attempt of all 2010-2012 BOC program participants and a follow-up (non-responder) phone survey of BOC program participants who had not responded to the Internet survey. The Internet survey was a 20- to 30-minute survey that explored participant characteristics, facility characteristics, actions taken, and program attribution. It also asked participants who took energy-saving actions for follow-up onsite visits or telephone calls to allow for more data collection to assist with estimating energy savings.

The non-responder phone survey was five minutes long and asked for limited participant characteristics, and whether the participants took any energy-saving actions post-program. This allowed us to understand more about the non-respondents to the Internet survey, and helped us to determine whether the non-respondents were in fact similar to the Internet survey respondents in terms of their buildings managed and propensity to take energy-saving actions. Comparative statistics between the two sample groups are presented in Appendix E.

Of the 836 participant contact records for the 2010-2012 BOC program provided by the IOUs, Opinion Dynamics identified 543 unique BOC program participants whose BOC certification had been verified by NEEC and whose records contained valid email addresses. In May 2013, we invited these participants to complete an internet survey; 94 participants responded, and 77 of them qualified for the study (i.e., completed some measure after the BOC program) and completed the full survey after one month in the field.

Table 4. Internet Survey Disposition

Course Timing	Population	Invalid Email Addresses	Total Survey Respondents	Full Completes	Not Qualified[c]
2010	190		26	22	4
Q1-Q2 2011	117		19	16	3
Q3-Q4 2011	115		20	14	6
Q1-Q2 2012	85		21	20	1
Q3-Q4 2012	36		8	5	3
Total	**543**	**24**	**94**	**77**	**17**
		Response Rate	17%		

[c] No facility/unemployed/non-participant/manage facility outside of CA; or terminated survey early (n=4)

With a 17% response rate,[7] the evaluation team was concerned about a potential non-response bias in this study, and particularly not knowing who the non-responders are. Therefore, in order to understand the characteristics of the BOC program participant population at large as compared to our internet survey respondents, we attempted a census of the contacts that had been invited to, but not participated in, the Internet survey. In June 2013 we called 431 contacts with valid phone numbers, and received 96 additional completes.

Between the two surveys we were able to collect some data from 190 (or 35%) of all 2010-2012 BOC program participants. Survey efforts for this study required multiple recruiting efforts, incentive offerings, and methods over the course of two months.

[7] We note that this level of response is becoming more typical for surveys, but because of the targeted nature of this survey and planned use of the data for the impact analysis, we deemed it prudent to look at non-responders.

Table 5 below details these efforts and the results in terms of study participation.

Table 5. Internet and Non-Responder Survey Methods and Outreach

Method Type	Outreach	Date 2013	Incentive	Cumulative Result by Method		
				Complete	**Unqualified**[b]	**Total**
Internet Survey	NEEC sends notification letter of upcoming survey	5/1	n/a	n/a	n/a	n/a
	ODC sends first survey invitation	5/7	NEEC continuing education credits[a]	18	3	21
	ODC sends first reminder	5/15	NEEC continuing education credits	30	6	36
	ODC sends second reminder	5/20	1-in-10 receive $50 Amex Gift card	41	8	49
	ODC sends third reminder	5/22	1-in-10 receive $50 Amex Gift card	50	11	61
	ODC sends fourth reminder	5/24	1-in-10 receive $50 Amex Gift card	61	11	72
	ODC sends fifth reminder	5/30	$25 to the first 30 who complete by 8pm on 6/8	67	12	79
	NEEC sends second notification letter	6/7	$25 to anyone who completes by COB 6/11	71	14	85
	ODC sends sixth reminder	6/10	$25 to anyone who completes by COB 6/11	77	17	94
Non-Responder Phone Survey	ODC performs five-minute survey with non-respondents to understand who they are, whether they took action	6/19 - 6/28	None	96	n/a	96
Total Data from BOC Program Participants				163	17	190

[a] Certified Building Operators must obtain continuing education units to maintain their certification. Offering these credits was one way the evaluation team used to obtain completed surveys.

[b] No facility/unemployed/non-participant/manage facility outside of CA; or terminated survey early

We used the BOC program curriculum to be sure that the Internet survey asked about all measures that BOC program participants were exposed to through their classes. This made for a somewhat lengthy survey because there were 103 measures included. Where reasonable, we binned curriculum measures into measures with the same name, and to reduce respondent burden we only asked about many measures at the highest level (i.e., "Did you install…" type of questions). For ease of reference and later analysis, these 103 measures were grouped into 11 categories shown below.

1. Boiler / Hot Water / Steam
2. Chiller / Chilled Water Systems
3. Cooling Tower Optimization
4. Domestic Hot Water
5. Economizer / Ventilation Controls
6. Fan Optimization / Air Distribution
7. HVAC Scheduling / Space Temperature
8. Lighting
9. Packaged / Split System HVAC
10. Water Pump Optimization
11. Other

During the survey, respondents were asked if they would be willing to talk over the phone with energy engineers at a later date, or allow us to perform an onsite audit to collect more detailed data.

3.1.2 Calculation of Energy Impacts

Of the 77 completed Internet surveys, we considered candidates for onsite audits only from the 48 who stated they installed measures. We called all 48 sites, and were successful at completing 15 onsite audits (see Table 6).

Table 6. Onsite Audit Disposition

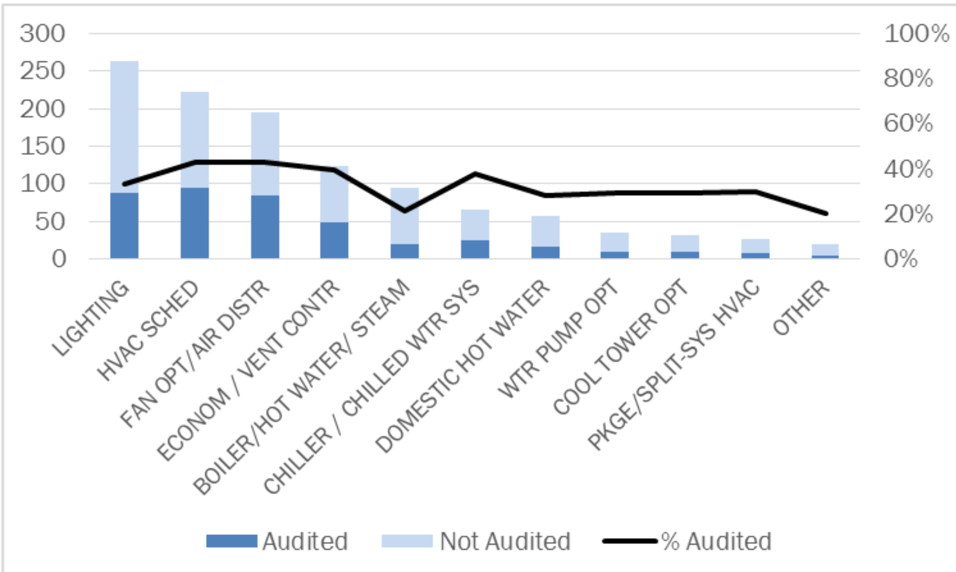
Disposition	Count	Percent of Total
Complete	15	31%
Refusal	14	29%
No Answer	19	40%
Total	48	

For each site visited, the engineers performed three main tasks:

1. Verified that the measures indicated on the surveys were installed and operating
2. Determined the timing of the measures to be sure that they were completed after any BOC program training
3. Gathered detailed information to allow for calculation of savings based on standard engineering algorithms and Excel models such as the bin method

Onsite audits varied in time from one to six hours. As stated earlier, there was a possibility of 103 unique measures installed, with little information known prior to the audit except that the respondent had chosen to implement at least one measure. For the 77 respondents completing the survey, there were 1,138 individual measures stated to have been taken. Onsite audits covered 407 (36%) of these measures. These audited measures covered all categories of measures, and covered from 20% to 43% of the measures within a category, averaging about 32% (see Figure 3 below).

Figure 3. Number and Percent of Measures within Survey and Audited[a]



[a] Appendix B provides a listing of all 103 measures by category, the number stated to have been implemented by respondents, and the number assessed by the audits.

Because of the heterogeneity and number of measures possible at a site (the number of measures varied from one to 62 at a site, with the average being 27 measures), we did not create a standard data collection instrument. We had asked more-detailed questions within the survey for lighting measures, and provided those values for the onsite engineers to include in their verification task. Otherwise the engineers reviewed each of the sites prior to the audit, and determined what type of information needed to be collected based on the known measures and an expected engineering calculation approach.

We employed four engineering approaches to calculate savings depending on the measure for what was most appropriate, and a single site may have used more than one method: simple engineering algorithms (six sites); engineering algorithms combined with a bin method to calculate full-load cooling or heating hours (four sites); engineering algorithms separated into 8,760 hours (seven sites); and a typical bin method (three sites). We did not use computer simulations such as eQuest, as the time and effort to create building models for these buildings was outside the scope of our analysis.

Savings for all lighting measures include application of a waste heat factor for both energy and demand. These values were obtained from the DEER database[8] and were applied by measure type

[8] DEER Lighting Measure Workbook - 19March2010.xls.

(CFL / non-CFL), IOU service territory, climate zone, and building type. Demand coincident factors came from the same source.

Weather-sensitive measures used TMY3 weather data within engineering calculations that were closest to the site. Design information, when included within the engineering calculations, came from ASHRAE Fundamentals 2013 for sites that were as close to the latitude and longitude of the site as possible.

3.1.3 Extrapolation to Internet Survey

The onsite audits were a nested sample of the Internet survey. We examined three possible methods to extrapolate to the larger information seen in the Internet survey, as shown below.

Potential Methods for Extrapolation:

- Average savings per square-foot: This option holds great appeal, as savings can be larger or smaller depending on the actual square-footage of a building. Larger buildings also typically have options available to them for savings not seen in smaller buildings.[9] We discarded this method after realizing that the square-footage values captured through the survey are too imprecise.[10] Application of savings by square-foot introduces unnecessary uncertainty.

- Average savings per site: This option is flawed, as it does not allow for the additional information captured within the Internet survey to be used, and the entire program savings would be based on the savings determined through our smallest data collection effort.

- Average savings per measure: This option was chosen as the best possible method to extrapolate savings from our more-detailed onsite audits to the Internet survey. Our audits covered a good representation of measures:

  - The onsite audits captured savings from 92 of the 103 possible measure types.[11]

  - Fifty-three (53) of 103 different measures had at least 10 instances of installation. For these measures, our onsite audits covered an average of 36% of the measures, ranging from 9% (for tankless water heaters) to 58% (for VFDs).

  - Not all 407 measures expected to be seen during the onsite audits were implemented. For those measures, a value of zero was included in our averages to account for measures not being implemented within the larger population as well.

Each respondent of the Internet survey indicated different numbers of measures installed across different measure categories. For each respondent we summed the total measures by measure category, and multiplied that value by the average measure savings to obtain total savings by site for kWh, kW, and therms (see Equation 1).

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[9] Although it is likely that all buildings within the BOC program could be considered large, as smaller buildings do not usually have a person like a facility manager who is a candidate for BOC program training.

[10] Close to 30% of respondents were able to provide only a range for the square-footage of the building, with ranges such as 250,000 – 750,000 being chosen.

[11] The 11 measure types not covered consisted of 26 out of the 1,138 measures (2.3%).

Equation 1

$$Savings\ by\ Site = \sum_{m=1}^{n} Number\ of\ Measures_m * \ Average\ Savings_m \quad .$$

Where:

m= the measure category

n = the number of measure categories accruing electric or natural gas savings

Three measure categories (lighting, economizer/vent, and fan optimization) had both kWh and therm savings. For these categories, we used the same number of measures but with the appropriate savings unit.

3.1.4 Extrapolation to Population

There were four options to consider when extrapolating savings from our Internet survey respondents to the population. The four variables known for the population that had the potential to be used were square-footage, sector, unique company, and number of people.

Potential Methods for Extrapolation:

- Square-Footage: We quickly dropped square-footage for consideration, as 20% of this variable were stated to be unknown and another 19% were simply shown as >1 million. With this level of uncertainty in the actual square-footage, gross impacts would also be highly uncertain.
- Sector: While energy use and savings are most likely correlated by sector, the data collected through our two census attempts were not sufficient to obtain robust savings by sector. This option was dropped.
- Unique Company: This possible method had appeal. We covered 28% of the unique companies within the Internet survey, and could have created an average savings by company to apply to the population of 236 unique companies within the 2010-2012 BOC program. However, we chose to drop this option for two reasons. Through our non-responders survey, we realized that the companies who had not completed the survey tended to control more than a single building (and thus could be inferred to be larger). As such, we were missing information from the larger population that could systematically bias our results. Additionally, an average savings by company is not a useful metric for forecasting future savings from the BOC program.
- Average Savings by BOC Program Participant: This was the best metric for moving the savings up to the population. It provides a useful metric for future programs, and recognizes that a unique company, where savings accrue, can include multiple BOC program participants.

There were 67 unique companies represented by the 77 completed Internet surveys. Not every BOC program participant in each of those unique companies completed a survey (see Table 7).[12]

[12] These 67 companies averaged almost 4 BOC program participants and ranged from 1 to 20 BOC program participants per company.

Table 7. Unique Companies within BOC Program Participants

Metric	Unique Companies		People	
	Number	Percent of Population	Number	Percent of Population
Population	236	100%	543	100%
Completed Survey	67	28%	77	14%
All BOC Program Participants within the 67 Unique Companies Completing the Survey			259	48%
Completed Survey and Stated to Have Taken Action	43	18%	48	9%

However, since our energy savings are at the site (i.e., company) level, and the savings are across all BOC program participants within that company, to appropriately extrapolate to the population we summed up all BOC program participants represented by the completed surveys. Equation 2 and Equation 3 show our calculations.

Equation 2

$$Savings\ per\ Person = \frac{\sum_{n=1}^{43} Savings\ per\ Site}{BOC\ Participants\ represented\ in\ Survey\ (259)}$$

Equation 3

*Gross Impacts = Savings per Person * Population of BOC Participants*

3.2 Net Impacts

The typical protocols followed for self-report in California were not practical for this effort. We were asking participants about up to 103 measures they may have implemented, and needed to contain our questions to broad categories. Because end uses often are correlated with actions already planned by participants, we chose to ask questions at the measure category level (i.e., the 11 categories described in Section 3.1.1, minus the “other” category). We kept to the main concepts of self-report by asking about the likelihood to have taken action absent the BOC program, the timing of the action taken, and the likelihood of having installed the same measure quantity absent the BOC program. Additionally, we captured an overall BOC program influence through a single question asking respondents to think about all possible reasons for taking action and letting us know what percent was due to the BOC program.

The measure categories included in the analysis and the number of respondents included in each category are shown in Table 8 below. By design, we had no responses for the category “Other.” The options for “other” responses within the survey covered multiple categories. Ultimately, we calculated an NTGR that was a weighted average across all categories to determine the NTGR for the “Other” category.

Table 8. Measure Categories Included in the Free Ridership Analysis

Measure Category	Number of Respondents Who Reported Installing Measure
Lighting	37
HVAC Equipment Scheduling / Space Temperature	26
Domestic Hot Water	24
Economizer / Ventilation Controls	21
Boiler/Hot Water/Steam System	16
Fan Optimization /Air Distribution	16
Chiller/Chilled Water Systems	13
Package/Split-System HVAC	13
Cooling Tower Optimization	11
Water Pump Optimization	10

Note: Respondents who completed multiple measures are included in more than one category.

Free ridership for each respondent (for each category)[13] is derived from responses to the participant survey, and is based on four factors: the BOC Influence Score, Program Likelihood, Program Timing, and Measure Quantity Likelihood. Questions from the participant survey used to determine free ridership and the NTGR are included in Appendix A.

Factor 1: BOC Influence Score

The BOC Influence Score captures the *relative* influence of the BOC program compared to other factors. Ultimately this concept was asked last to allow for participants to bring to mind many of the possible influences involved with actions taken after their BOC program training. Respondents were first given a question battery regarding likelihood to take action, likely timing of action, and likely quantity of actions taken absent the program (discussed in more detail in Factors 2 through 4 below).

Once the respondent had thought through these questions on BOC program influence, we then presented a number of "other influencing factors." These factors included, for example, rate of return on investment, reducing operating costs, and their company's commitment to going green or saving the environment. We asked respondents to give an influence score on a scale of 1 to 10, where 1 is "not influential" and 10 is "very influential," for each of these other factors. Then we asked respondents to weigh the influence of these other factors compared to the BOC program's influence by allocating 100 "influence points" between the BOC program and "other influencing factors" in terms of their decision to take the energy-saving actions that they did. Each respondent was asked this question only once, and the same score was applied to each of their measure categories. Higher free ridership is associated with respondents who allocated fewer influence points to the BOC program, as this would suggest that they were more influenced by factors other than the BOC program.

Factor 2: Program Likelihood

[13] Participants may have completed measures in multiple measure subgroups, and therefore may have multiple free ridership scores.

Program Likelihood was calculated for each measure category and is based upon the reported likelihood that respondents would have taken the same energy-saving actions if they had not participated in the BOC program. Higher free ridership is associated with those who were more likely to take energy-saving actions without the training.

This was the first question asked in our attribution battery. Those who responded that they *would not have* taken action previously were considered 100% influenced by the program. Typically, self-report analyses do not use this type of single question application for a free ridership value. However, given the survey length and free ridership values for a large number of categories, the choice was made to use this single question. Those who responded "don't know" or "maybe" were assigned free ridership scores based on their BOC Influence Score. Finally, those who indicated that they *would have* taken action absent the BOC program were given an initial program likelihood score equal to 1 (meaning 0% influenced by the program), and then asked follow-up questions to determine adjustments to this influence score (i.e., calculation of partial free ridership).

Factor 3: Program Timing

Partial free ridership takes the timing of actions taken into account. Program Timing was calculated for each measure category, and is based on whether the BOC program caused respondents to take energy-saving actions earlier than they would have otherwise. This question was only asked of those who indicated that they would have been likely to take the same actions that they did absent the program.[14] While respondents may have completed the same action without the program, the BOC program may have enabled them (i.e., with skills, information, resources, etc.) to complete these actions earlier than expected. Using typical timing periods, we considered a program influence on anyone who took actions more than six months earlier than they originally planned. Those who would have completed actions at the same time or within six months are considered to not be influenced by the program. Often, in a commercial setting, actions completed within six months likely would have been in the planning process at the same time, as they would have been absent the program.

This factor cannot increase free ridership, but can account for partial influence of the program and reduce the free ridership value. Thus, any respondents who indicated some influence in terms of the timing of their actions were given a downward adjustment to their free ridership score.

Factor 4: Measure Quantity Influence

The second factor for partial free ridership is focused on measure quantity. Measure Quantity Influence takes into account that respondents may have installed more measures than they otherwise would have due to the BOC program training they received (i.e., due to improved knowledge of the benefits of the measures installed).[15] This score was calculated only for lighting and domestic hot water measures, as these categories have the highest likelihood of cases in which respondents may have installed multiple measures of the same category (i.e., multiple bulbs).

Measure Quantity Influence asked respondents whether they would have completed fewer, the same, or more energy-saving actions had they not participated in the BOC program. Higher free ridership is associated with those who would have completed more or the same number of actions had they not

[14] The Program Timing Score does not impact the free ridership score of those who reported that they would not have completed the same actions without the training.

[15] The Measure Quantity Influence Score does not impact the free ridership score of those who reported that they would not have completed the same actions without the training.

participated in the program. Any respondents who indicated that they would have installed fewer measures without the program were given a downward adjustment to their free ridership score.

While most respondents indicated that they would have installed fewer or the same number of measures, there were five cases (or 10%) in which respondents indicated that they would have installed more measures without the program. Because we cannot be sure why they would have installed more measures, we assigned the same score to these respondents as those who would have installed the same number of measures. Ultimately, our choice here made no difference in the overall NTGR for the measure category.

Free ridership scores for each respondent are averaged to determine the score for a given category. The algorithm for calculating free ridership and the NTGR for each measure category is presented in Figure 4 below.

Figure 4. NTGR and Free Ridership Calculation for BOC Program (By Measure Category)

$$NTGR_{category} = 1 - Freeridership_{category}$$

Where:

$$Freeridership_{category} = Average(Freeridership_{respondent})$$

Where:

$$Freeridership_{respondent} = Factor\ 1 * Average(Factor\ 2, Program\ Influence)$$

Where:

$$Program\ Influence = Average(Factor\ 3, Factor\ 4)$$

We calculated an NTGR for each respondent by measure category, and weighted the overall measure category by the measure category gross impacts.

4. BOC Program Participant Characteristics

The two surveys fielded for this effort (i.e., the original Internet survey and the follow-on non-responder survey via telephone), provide a good representation of the overall population in terms of sector. The non-responder survey brought out significant differences in terms of: 1) the number of participants who manage a facility and 2) the number of buildings managed.

Table 9 shows that the sectors represented within the Internet survey are closely aligned (i.e., within 5%) with the population of BOC participants with a few exceptions. The Internet survey saw a higher percentage of unique companies within the hospitality sector.

Table 9. Unique Company by Sector – Population and Internet Survey

Sector	Unique Company			Percent of Total		
	Population	Internet Survey	Onsite Audit	Population	Internet Survey	Onsite Audit
College	37	13	2	16%	19%	14%
Municipality (City, State, or Utility)	32	9	0	14%	13%	0%
Other	27	4	1	11%	6%	7%
Healthcare	22	7	1	9%	10%	7%
Manufacturing	21	4	1	9%	6%	7%
Military	16	3	0	7%	4%	0%
Hospitality	15	9	2	6%	13%	14%
K-12 School	15	2	1	6%	3%	7%
Property Management	15	4	0	6%	6%	0%
Government	10	2	1	4%	3%	7%
Retail	9	3	2	4%	4%	14%
Facility Services	6	1	0	3%	1%	0%
Government (Not City- / State-Specific)	6	5	3	3%	7%	21%
(None Given)	5	1	0	2%	1%	0%
Total	236	67	14			

As stated above, there are two main areas where non-response bias is seen; the proportion of participants who manage a facility and the number of buildings that a participant manages. The first area does not adversely affect the gross impacts, while the second area could cause our savings to be underestimated.

Table 10 below shows that, not surprisingly, if a person did not currently manage a building, they were less likely to respond to our Internet survey. It also indicates that about 15% of BOC program participants eventually move out of a job where their skills and knowledge learned within the BOC program can affect building energy use.[16] Table 10 also indicates that participants who take energy-saving actions were more likely to respond to our Internet survey (28% took action in the internet survey but only 16% said they took action in the phone survey) and give us detailed information about those actions. Neither of these differences is assumed to adversely affect the overall gross impacts. We used this information to extrapolate our findings and ensure that we did not overestimate savings. That is, the impact calculations used data from both surveys to determine the percent of attendees likely to take action (i.e., 80%).

Table 10. BOC Participants – Facility and Actions

BOC Attendee Facility Management Status	Internet Survey	Non-Respondents	Total
	(n=90)	(n=96)	(n=186)
Managing a facility & took action	58%	57%	58%
Managing a facility & did not take action	28%*	16%	22%
Not managing a facility now/Did at time	6%	23%*	15%
Not managing a facility now/Did not at time	6%	4%	5%
Managing a facility not in CA	1%	0%	1%
Do not recall participating in BOC program	2%	0%	1%
Total	**100%**	**100%**	**100%**

*Statistically different when comparing internet survey respondents and non-responders at 90/10 confidence.

*Percentages may not add to 100% due to rounding.

As shown in Table 11, we also saw a bias in our responses from those who manage multiple buildings.

Table 11. Number of Facilities Overseen
(If Manager of a Facility)

Facilities	Internet Survey	Non-Responders	Total
n	77	70	147
One facility	57%*	32%	44%
Multiple facilities	40%	66%*	53%
(Don't know)	3%	2%	3%
Total	**100%**	**100%**	**100%**

*Statistically different when comparing internet survey respondents and non-responders at 90/10 confidence.

This difference could affect the impacts, but in unknowable ways that cannot be handled within the analysis. It is possible that the difference in number of facilities managed means that the number of

[16] Remember that the some of the participants took BOC classes in 2010, or more than three years ago.

measures described in our analysis may be lower than found in the population. As such, our analysis may underestimate savings from the trainings. Additionally, the likelihood of implementation may be more or less likely within multiple facilities. If implementation of measures is more likely than what we found in our onsite audits, then our savings may again underestimate actual savings. If participants who manage multiple facilities have a lower likelihood of implementing measures (for reasons such as more hassle obtaining capital investments within larger sites), then our findings may overestimate savings.

Given the two main caveats mentioned above, below are the key takeaways from the Internet survey in terms of participant characteristics, propensity to take action post-training, and types of actions taken.

Overall Participant Characteristics

- Based on survey results, we estimate that 80% of all BOC program participants directly manage a facility or conduct maintenance operations, and therefore are in a prime position to take energy-saving actions at a facility post-training (although that does not necessarily mean than they do take action).
  - The remaining participants are in maintenance-related positions (such as a plumber), administrative energy management positions, energy management consultants, students (8%), are unemployed (6%), have switched careers, manage facilities outside of CA, or do not recall attending the BOC training.

Facility Manager Participant Characteristics

Data collection efforts continued with the subset (80%) of respondents who directly manage a facility or conduct maintenance operations, in order to better understand the facilities they manage and the actions taken for the impact evaluation. Among these participants:

- BOC program participants manage a wide variety of facilities with varying uses. The most common types of facilities that are managed by BOC program participants are government (26%), schools (14%), office buildings (9%), hospitals (7%), and hotels (6%).
  - On average, BOC program participants have 4 employees at their organizations that have a BOC certification. However, this ranges from 1 employee to as high as 22 employees.
  - One-third of BOC program participants have also attended other courses at the Energy Centers throughout the state.
  - Participants vary widely in terms of the number of facilities they oversee; 44% oversee one facility and 53% oversee multiple facilities.[17]
  - Most BOC program participants (81%) work for businesses that own (rather than lease) their facilities.
  - Although these data were provided by a smaller portion of the respondents, are highly variable, and ultimately not used in the gross impacts, we present some information on facility sizes to give a sense of the sites managed by participants. The square-footage per facility ranges from

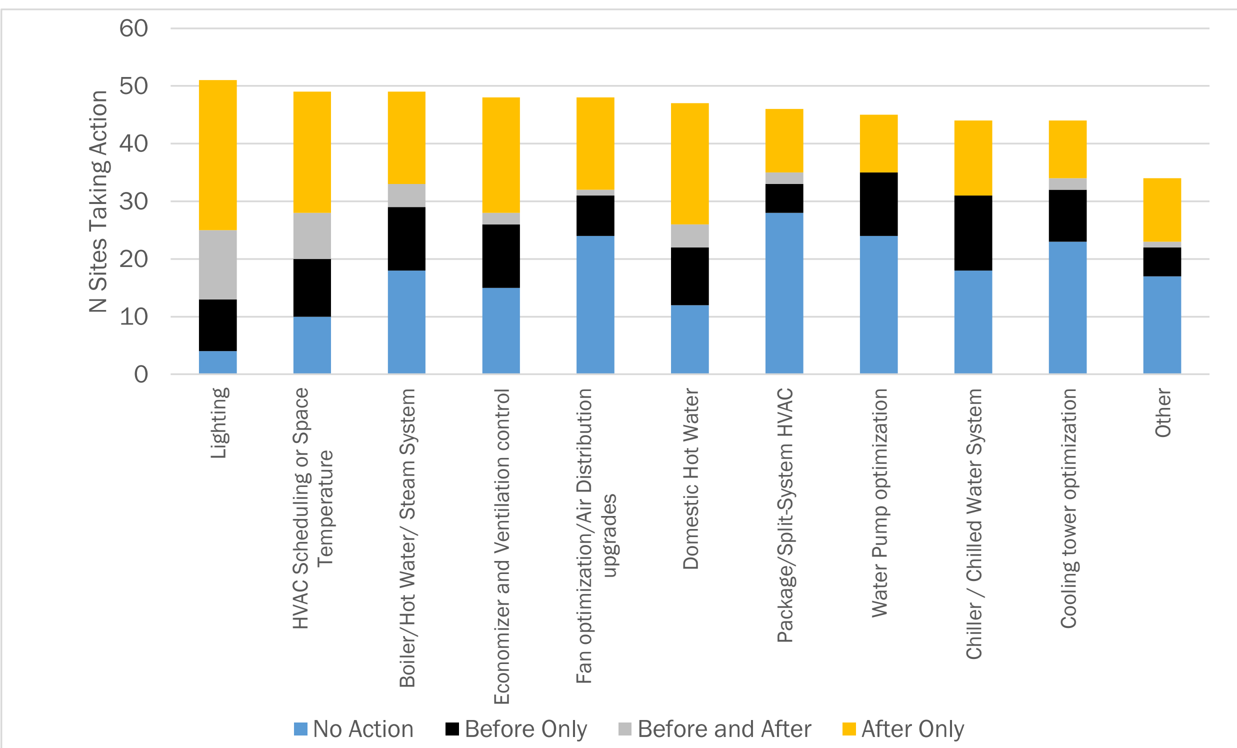
[17] Three percent (3%) did not know how many facilities they oversee.

2,000 square-feet to up to 500,000 square-feet; the median is 60,000 square-feet. In terms of occupants, facilities range from 2 occupants to up to 6,000 occupants; the median is 250 occupants per facility. The total annual energy cost per facility also ranges widely, from as low as $23K per year to up to $4.4M per year; the median is $550K per year. The majority of energy costs (74%) are spent on electricity.

Taking Action

- Among the 80% of participants who are facility managers or conduct maintenance operations, 73% stated taking some type of energy-saving action post-program. Therefore, when looking at the total population, more than half of all total participants (58%) stated taking some of type of energy-saving action post-program.
  - 39% received the training in 2010, 33% in 2011, and 28% in 2012.
  - Alternatively, looking at the propensity to take action by program year, it seems as though more participants in recent years took some action post-program; 10% from 2010 took action, and this increased to 15% from 2011, and 23% from 2012. *It is possible that more recent respondents have better recollection of what they did post-program*.
- BOC program participants are taking action even before any BOC program training. Figure 5 below shows that for participants who manage a building and took action of some sort after their training, there are instances when actions taken solely after the BOC program are greater than actions taken only before or both before and after. At a high level, the BOC program appears to have brought about more actions for lighting, economizers, fan optimization, and domestic hot water measures, as there are subjectively more actions taken after the BOC program than before.

Figure 5. Actions Taken Before and After BOC Program Training



- Among those who took action, 29% think the actions lead to significant energy savings, and another 50% think they lead to moderate energy savings.
- Among those who did not take any action, the most common reasons were budgetary constraints, the perception that they are already managing highly efficient buildings and there were few or no opportunities to do more, and/or they are not a decision-maker.
- Four in 10 participants monitor their facilities' energy use and hourly load shape since the training. Most of them are using energy management tools such as METASYS or SCE's Energy Manager Tool.

Motivations and Course Value

- When asked why participants sought a BOC program certification, the most common reasons were for career development (52%), to save energy at their facility or create a more efficient facility (32%), and/or to help save money at the facility (16%).
- When asked for the most important skills or topics they learned in the program, 62% of respondents mentioned an important skill or topic, while the remainder chose not to answer this question. Respondents mentioned a wide variety of skills and topics, but mostly they related to learning how to maximize energy savings and increase efficiency; how to maintain equipment and why it is important; and how to track and report on energy usage.
- Further, in terms of course value, amongst facility managers:
  - 97% said the course provided them with new information
  - 92% said the course increased their knowledge of energy efficiency opportunities at their facilities
  - 79% said the course moved them closer to implementing efforts to save energy that they were already considering
  - 68% said the course increased their knowledge of rebates and tax incentives available

Next we present the gross impacts determined using information from completed surveys and onsite audits.

5. Gross Impacts

The gross impacts are built up from the detailed onsite audits and eventually extrapolated up to the population through the methods described above. We provide relevant information at each step next.

5.1 Onsite Audit Sites

For the most part, the engineers performing the onsite audits were able to spend sufficient time at the sites to collect needed information. There were three sites where we had specific difficulty (bulleted below). In these cases, we simply set those measures to “unknown if implemented,” and they are not included in our impact analysis.

- For one site, the site engineer best able to describe the measures could not spend time with us, and the other facility managers we were able to work with were not knowledgeable about specifics regarding HVAC and fan scheduling measures.
- At another site, there were security concerns for two of the three buildings of our planned audit, and we were not able to verify any measures except in one building.
- One site was a very large campus and the site engineer did not have sufficient knowledge to point us to the most appropriate building to find most of the expected lighting measures, nor was there any paperwork to determine where these upgrades may have occurred.

Our research shows that it is crucial to perform onsite data collection for this type of program. As described earlier, the onsite audits covered 407 measures stated to have been implemented within 43 unique companies. When going onsite, just over one-third of measures were actually verified as implemented,[18] as shown in Table 12.

Table 12. Measures Implemented by Category
(Self-Report in Survey)

Measure Category	Self-Reported Survey Measures (A)	Measures We Could Determine if Implemented or Not (B)	Verified Implemented Measures (C)	% Implemented (C/B)
Domestic Hot Water	16	16	12	75%
Lighting	87	81	53	65%
Package / Split-System HVAC	8	6	3	50%
Other	4	4	2	50%
Boiler / Hot Water / Steam System	20	20	8	40%
Economizer / Ventilation Controls	49	49	16	33%

[18] Of those measures where we could determine if implemented or not.

Measure Category	Self-Reported Survey Measures (A)	Measures We Could Determine if Implemented or Not (B)	Verified Implemented Measures (C)	% Implemented (C/B)
Water Pump Optimization	10	10	3	30%
HVAC Equipment Scheduling / Space Temperature	95	77	12	16%
Chiller / Chilled Water Systems	25	25	4	16%
Fan optimization / Air Distribution	84	78	12	15%
Cooling Tower Optimization	9	9	1	11%
Total	***407***	***375***	***126***	***34%***

We also found measures installed after the BOC program, but not included in the responses provided in the survey. There were far fewer of these measures (29 measures added), with the majority (83%) coming from lighting.

All BOC program participants could use funding from incentives within the energy efficiency portfolio. Itron maintains a database of measures with incentives paid in PY2010-2012. Through a database cross-checking (by company name and address), Itron provided the evaluation team with a listing of all possible measures for companies completing our survey. To be sure we did not double-count incented measures, we reviewed these measures for overlap with the BOC program measures, and removed savings for the 12 measures found to overlap. Table 13 shows the total number of measures included in our gross impact averages, as well as how they were derived.

Table 13. Measures Implemented by Category
(Used within Gross Impact)

Measure Category	Implemented or Not Measures from Survey (A)	Implemented Measures Added During Onsite Audit (B)	Incentivized Measures (C)	Total Measures Included in Gross Impact Calculations (A+B-C)
Lighting	81	24	6	99
HVAC Equipment Scheduling / Space Temperature	77	0	1	76
Domestic Hot Water	16	0	2	14

Measure Category	Implemented or Not Measures from Survey (A)	Implemented Measures Added During Onsite Audit (B)	Incentivized Measures (C)	Total Measures Included in Gross Impact Calculations (A+B-C)
Economizer / Ventilation Controls	49	0	0	49
Boiler / Hot Water / Steam System	20	1	0	21
Fan optimization / Air Distribution	78	1	0	79
Chiller / Chilled Water Systems	25	1	0	26
Package / Split-System HVAC	6	0	0	6
Cooling Tower Optimization	9	0	0	9
Water Pump Optimization	10	0	1	9
Other	4	2	2	4
Total	***375***	***29***	***12***	***392***

The BOC program curriculum and the specific measures used within our survey cover actions around purchases of equipment and operations and maintenance (O&M). Of the 103 measures possible, 94 unique measures were stated to have been installed. We labeled each of the measures into four categories: equipment purchases, O&M, both, and unknown (the full listing of measure by BOC program action type is available in Appendix C). Table 14 shows that more than half of the possible actions that were part of the survey are O&M actions.

Table 14. BOC Action Type by Unique Measure Category
(Equipment Purchase and Operations & Maintenance)

Measure Category	n Unique Measures	Equipment Purchase	O&M	Both	Unknown (Other)
PKGE/SPLIT-SYS HVAC	1	100%	0%	0%	0%
LIGHTING	12	92%	8%	0%	0%
DOMESTIC HOT WATER	6	83%	0%	0%	17%
COOL TOWER OPT	5	40%	60%	0%	0%

Measure Category	n Unique Measures	Equipment Purchase	O&M	Both	Unknown (Other)
BOILER/HOT WATER/ STEAM	11	36%	64%	0%	0%
CHILLER / CHILLED WTR SYS	11	36%	64%	0%	0%
ECONOM / VENT CONTR	11	27%	64%	9%	0%
FAN OPT/AIR DISTR	20	25%	70%	5%	0%
WTR PUMP OPT	4	25%	75%	0%	0%
HVAC SCHED / SPACE TEMP	12	0%	100%	0%	0%
OTHER	1	0%	0%	0%	100%
Total	**94**	**38%**	**57%**	**2%**	**2%**

While Table 14 above shows the percent action type by *unique* measure category, participants told us they performed many actions within each of these categories. The measures verified to have been implemented were skewed toward equipment purchases. Table 15 below shows the original 392 measures stated to be installed spread out across purchases versus O&M actions, and then the measures that were found to be installed by the evaluation team.

Table 15. Measure Action Types in Gross Impact Analysis

Measure Action Type	All Measures	% by Action Type	Measures Where Took Action[a]	% by Action Type
Equipment Purchase	173	44%	102	72%
O&M	202	52%	38	27%
Both	10	3%	0	0%
Unknown	7	2%	2	1%
Total	392		142	

[a] Total of 142 based on the 126 verified noted in table above, plus the 29 new measures found at the site and taking out 12 incentivized measures. There is one lighting measure that is both new and incentivized. It is removed here in the new measures count to obtain a total of 142.

Even though the majority of actions being taken were equipment purchases, few of these were incented through the programs (nine of the 12 incented measures were equipment purchases).

Following the methodology described in Section 3.1.2, we calculated the savings per measure as shown in Table 16.

Table 16. Average Annual Savings by Measure Category

Measure Category	n Measures	kWh/ Measure	kW/ Measure	Therms/ Measure
Lighting	99	25,325	4.54	(26)
Chiller / Chilled Water Systems	26	22,611	2.58	-

HVAC Equipment Scheduling / Space Temperature	76	14,535	0.82	660
Other[a]	4	12,684	0.71	-
Water Pump Optimization	9	11,781	0.89	-
Fan optimization / Air Distribution	79	9,540	1.09	460
Economizer / Ventilation Controls	49	7,628	2.26	463
Package / Split-System HVAC	6	4,604	0.53	-
Boiler / Hot Water / Steam System	21	1,106	0.09	720
Cooling Tower Optimization	9	509	0.06	-
Domestic Hot Water	14	-	-	384
Total	***392***			

[a] "Other" impacts had been labeled as "other" by the respondent. This was an eclectic mix of measures (heat pumps, replacing evaporative motors with ECMs, direct digital temperature controls, and vending misers). Because the respondent had labeled them as "other" and we determined what the measure was during our onsite audits, we did not move their responses, even though there were more-appropriate categories.

5.2 Extrapolating Findings to Surveyed Population

As stated earlier, the Internet respondents who managed a building and stated that they took some sort of energy-saving action completed 1,138 measures. These measures were spread out across the measure categories as shown in Table 17.

Table 17. Number of Measures in Surveyed Population

Measure Category	N Measures
Lighting	263
HVAC Equipment Scheduling / Space Temperature	223
Fan Optimization / Air Distribution	196
Economizer / Ventilation Controls	124
Boiler / Hot Water / Steam System	97
Chiller / Chilled Water Systems	66
Domestic Hot Water	57
Water Pump Optimization	34
Cooling Tower Optimization	31
Package / Split-System HVAC	27
Other	20
Total	***1138***

Using the methods discussed in Section 3.1.2, we determined the overall savings for each Internet survey, and summed them to obtain the impacts from just those interviewed (see Table 18).

Table 18. Surveyed Respondents Gross Impacts

Metric	kWh	kW	Therm
All Surveyed Respondents	15,004,350	2,101	230,518

As described above, survey non-responders tended to be from unique companies that had larger numbers of buildings covered in their sites. Given this known bias, our impacted values may be low, but to what extent is unknown. We have not adjusted any savings based on the known non-response.

5.3 Program Gross Impacts

The 2010-2012 statewide BOC program garnered approximately 25 GWh in annual gross electric and 387 kTherm (thousand therms) in annual gross natural gas impacts, as shown in Table 19 below). To give a sense of the magnitude of these savings, the overall 2010-2012 California Energy Efficiency Portfolio installed 10,505 GWh of electric savings[19] and about 185 MTherm (million therms) in natural gas impacts. If this program had been included as an energy resource within that program year (which it was not), it would have added about 0.2% more to savings from both fuels.

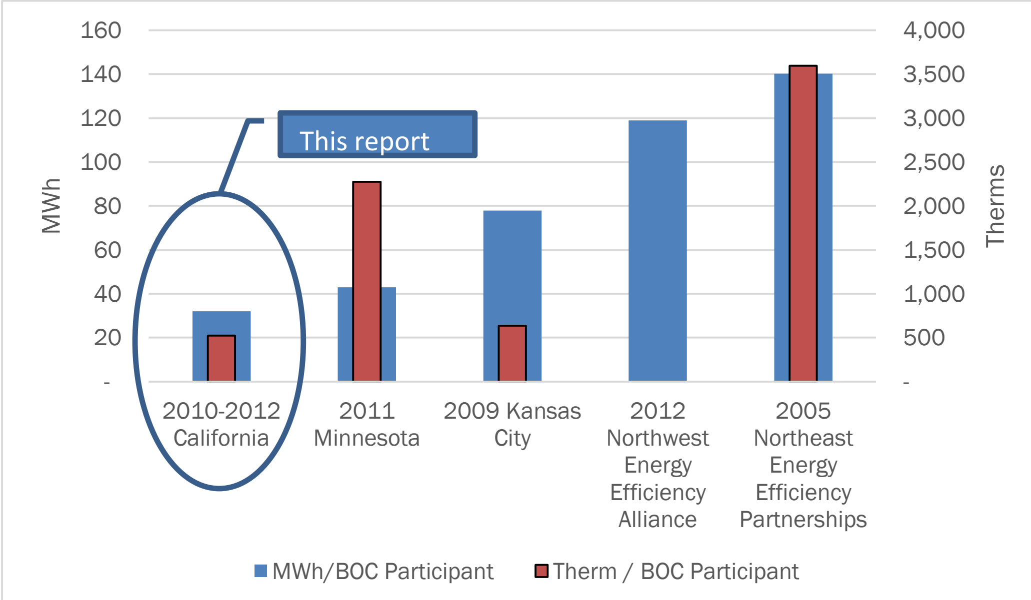
Table 19. 2010-2012 BOC Program Gross Impacts

Parameter	MWh	MW	kTherm
Impacts from Internet Survey Participants (impacts from measures that have been incentive are removed)	15,004	2.10	230.5
People Represented by Companies Completing the Internet Survey	259		
Impacts/Student	57.93	0.01	0.89
People in Population	543		
Percent of Population that Manages a Facility	80%		
Total Impacts (Impacts/Student * Students * % Managing Facility)	25,166	3.52	386.6

The estimated impacts from this program are in the middle of what other evaluations have found for therms, and lower than three of the other four reports in terms of electric energy savings.

[19] EEGA website for the 2010-2012 period. Value is estimated from graph of installed measures.

Figure 6. Comparison of California Impacts with Other BOC Program Impact Reports



6. Net Impacts

Table 20 shows that the NTGR varied from a low of 0.67 (for lighting) to a high of 0.91 (for water pump optimization).

Table 20. BOC Program NTGR Results

Measure Category	Number of Respondents (n)	Average NTGR Electric	Average NTGR Therm
Water Pump Optimization	10	0.91	-
HVAC Scheduling / Space Temperature	26	0.82	
Cooling Tower Optimization	11	0.79	-
Domestic Hot Water	24	0.76	0.76
Fan Optimization / Air Distribution	16	0.76	0.76
Boiler / Hot Water / Steam System	16	0.73	0.73
Package / Split-System HVAC	13	0.73	-
Economizer / Ventilation Controls	21	0.71	0.71
Chiller / Chilled Water Systems	13	0.70	-
Other	n/a[1]	0.69	-
Lighting	37	0.67	-
All Categories		0.69	0.74

[1] By design, we had no responses for the category "Other." The options for "other" responses within the survey covered multiple categories. Ultimately, we calculated an NTGR that was a weighted average across all categories to determine the NTGR for the "Other" category.

With lighting as the category with the largest savings, the NTGR pulled the overall NTGR down. These researched values are in line with other resource acquisition program values. NTGR provided in the DEER database site[20] show that the NTGR are comparable.

Table 21. Comparison of Select BOC Program NTGRs with DEER Values

Data From DEER		Data from this BOC Report	
Measure Category	NTGR	Measure Category	NTGR
Linear Fluorescent	0.70	Lighting	0.67
Retrocommissioning	0.80	HVAC Scheduling	0.82
		Cooling Tower Optimization	0.79
Packaged HVAC Servicing	0.73	Packaged HVAC Purchase	0.73
Chiller	0.58	Chiller/Chilled Water Systems	0.70

[20] DEER2011_NTGR_2012-05-16.xlsx.

The NTGRs applied in the net impacts are based solely on the responses within the survey. However, we saw some anecdotal evidence of influence (or not) of the BOC program during our on-site audits. While we provide a short description of each site in Appendix A, a few noteworthy items are included below.

- Anecdotal evidence of influence:
  - Respondent A: *Most of the projects that he indicated on the survey were future projects that the site plans to implement in the next couple of years*.
  - Respondent C: *The facility manager found it [the BOC program] extremely helpful and has been doing a lot to help his facility save energy. He has been implementing measures incrementally, by introducing these changes to his facility gradually. This has shown management that the training was beneficial and that there is a lot of potential for decreasing energy consumption. More projects are planned in the future as a result of the BOC training.*
- Anecdotal evidence of no influence:
  - Respondent D: *Facilities' staff provided the training to their engineers and technicians to educate them about the energy-efficient strategies that the new central plant would be using. They said it was a helpful training, and that the technicians took a lot away from it. The central plant replacement was not implemented as a result of BOC training, rather the BOC training was taken as a result of the chiller plant replacement.*

The 2010-2012 Statewide California BOC program brought about slightly more than 17,000 MWh of electric savings and 0.285 million therms that otherwise may not have occurred (see Table 22).

Table 22. 2010-2012 BOC Program Net Impacts

Parameter	MWh	MW	kTherm
Gross Impacts	25,166	3.52	386.7
NTGR	0.69		0.74
Net Impacts	17,387	2.43	285.2
Per-Person Net Impacts	32.02	0.0045	0.525

7. Summary of Findings

We provide a summary of the specific research questions and answers in Table 23.

Table 23. Summary of Research Questions and Answers

Question Number	Research Question	Research Answer
1.	What are the baseline O&M practices that BOC program participants employ in their facilities, and what energy-efficient equipment was in place prior to participation in the program?	Given the large number of measures, we cannot answer this directly with our primary data. However, we can infer this from two of our data sources. Figure 5 shows that BOC participants are taking actions both before and after the training. These data are only available at the measure category level, and not at the measure level (which separates into equipment and O&M). We have taken the known number of measures within each category that could be considered O&M and shown those data within the same figure. Many BOC participants were already optimizing their fan, water pump, and cooling tower systems as well as purchasing packaged HVAC prior to participation. The BOC training appears to have increased the number of actions taken for lighting and domestic hot water (mainly equipment purchases) and HVAC scheduling (all O&M actions).
2	What are the gross annual energy (kWh and therm) and peak demand (kW) savings from participating facilities?	Table 19 shows the gross impacts are 25,166 MWh, 3.52 MW, and 386.6 kTherm
2a	What are the gross energy-savings impacts per participant? Per square-foot? Per series? Per site address (or company)?	Table 19 shows the gross savings per student are: 57.93 MWh, 0.008 MW, and 0.89 kTherm. (543 people) Gross saving per site address are: 106.6 MWh, 0.015 MW, and 1.64 kTherm (236 sites) We cannot determine a gross impact per square foot due to poor quality of data. We do not determine a gross impact per series as the sample sizes are not adequate to reliably show whether taking a Level 2 series may provide additional savings.
2b	Which actions are most frequently taken by BOC program participants? Which of these actions results in the highest energy savings?	Table 15 shows that BOC participants are most often purchasing equipment (72% of the measures taken were purchases). By category, Table 16 provides the average annual savings by measure category for

Question Number	Research Question	Research Answer
		all categories. Table 16 shows that the top three categories where BOC participants are taking actions are lighting, fan optimization / air distribution, and HVAC scheduling. Lighting provides the highest savings per action taken at 25,325 kWh per measure.
3	What amount of channeling occurs from the BOC program to the IOU's energy efficiency rebate programs, and how much energy savings is attributable to the BOC program (i.e., what is double-counted)?	We found minimal channeling between the BOC program and IOU energy efficiency rebate programs. Only 12 of 392 actions taken by BOC respondents (3.1%) were also found in the database of 2010-2012 Energy Efficiency paid measures. We removed these measures prior to gross impacts so do not double-count them. However, if left in, they would account for an additional 11% of MWh, 12% of MW, and 8% of kTherm impacts. This somewhat disproportionate savings is because half of the incented measures were lighting where the savings per measure is highest.
4	What are the net energy-savings impacts due to participation in the program?	Table 22 shows the net impacts are 17,387 MWh, 2.43 MW, and 285.2 kTherm
4a	To what degree has the program influenced participants' decisions to install energy-efficient equipment or take O&M actions?	Similar to resource acquisition programs, slightly over two thirds of actions occurred due to BOC training.
5	What is the persistence of energy-saving actions over time?	Initially desired but not quantified in this study due to project budget and timing constraints

8. RESEARCH AREAS FOR FUTURE CONSIDERATION

The net-to-gross research to date determines the motivating factor for changes in participants' practices. It seems reasonable to balance the response about "their likelihood of doing it anyway" or their percentage of influence of BOC in taking the action with the concrete and observable phenomena of the time sequence to which the event happened. In the operations world, many of participant's actions could have happened any time prior to the training. The IOU's have been offering information and encouragement to take these energy savings actions for almost 3 decades. But yet those actions were not taken until participation in BOC. It would be interesting to explore how this factor can be incorporated into the NTG methodology in future research.

Further regarding NTG, this research chose a complex method for calculating NTG. However, other methods could have been explored such as taking a simple average or removing don't know responses. It would be interesting to see how the NTG might change if these different approaches were explored. Future research could decide to explore these scenarios and how they impact the final results.

Finally regarding NTG, some participants mentioned that the decision to take certain actions was made prior to the BOC training. However, it is possible that someone else at the organization participated in the BOC program in a prior program cycle. Future research might consider asking whether others at the organization got BOC certified in the past. This could also be explored by analyzing the participation records from prior program cycles.

This study measures the energy savings effect of proactive energy efficiency actions and measures. Energy savings may also occur from "actions not taken". For example, BOC encourages operators to consider energy implications of actions from a systems perspective. There could be savings occurring as operators amend how they react to what are the most ubiquitous challenges to day-to-day operations – such as response to extremely hot or cold weathers. Operators prior to BOC training might have reacted to those situations by over-riding controls or simply increasing/decreasing supply air temperature set points. BOC provides alternatively approaches to these types of reactive strategies. In these cases, it is the action NOT taken that produces energy savings. While this is challenging to measure it should be taken into consideration in future research to see if there is a feasible way to measure this potential savings.

This study reported that there is little program channeling between BOC and other non-residential rebate programs. This is somewhat surprising given the amount of time the BOC training program spends on educating participants on the incentives available to them. Future research could explore why this is happening.

Calculating the cost-effectiveness of this program was outside the scope of this study. However, savings estimates from this study could be used as inputs to help quantify this in the future. Future research could explore the cost-effectiveness of this program.

Non-response bias was an issue in this study despite the multiple attempts made to mitigate this potential. Future research should explore the attempts made to gain study participation in this report and consider alternatives that might better address this issue.

This study found that among those who did not take any action, the most common reasons were budgetary constraints, the perception that they are already managing highly efficient buildings and there were few or no opportunities to do more, and/or they are not a decision-maker. Future research could explore whether financing opportunities could help overcome some of these barriers.

While not explicitly covered in the research objectives for this study, the Coalition of Energy Users suggested the following researchable areas for consideration in future BOC evaluations.

- Studies in the future may take a more longitudinal approach given that BOC participants may install measures or make operational changes that are influenced by BOC training over the course of many years.
- Studies in the future may explore why participants do not complete certification training.
- Studies in the future may explore whether the BOC program may increase free-ridership in energy efficiency incentive programs.
- Studies in the future may employ a comparative energy savings analysis amongst BOC-certified building operators and non-certified building operators who have received energy efficiency incentives/rebates. Such an effort might explore whether educational training is more cost-effective in realizing energy efficiency improvements than incentives/rebates.

A. Summaries for Onsite Audited Sites

The evaluation team audited buildings for 15 unique customers. This Appendix contains executive summaries of some of the engineering information found at the site, as well as anecdotal attribution information.

2107 – EXECUTIVE SUMMARY
Site 2107 is a hotel that consists of two separate buildings. Each building is composed of four stories that house suites with up to two bedrooms. The building manager mentioned that guests at their facility typically use their grounds for longer periods of time than guests at traditional hotels. Some guests live there more than a few weeks when away for business. All suites are equipped with a full kitchen (including stove, full-size refrigerator, microwave, and oven). Each room is conditioned by means of a PTAC unit. 20 PTAC units have been replaced with new equipment. The facility plans to replace 63 more in the next three months. The common area hallways are conditioned by 13-year-old split A/C units, where two units are used for each floor, with a total of 16 split systems for the entire facility. One unit is responsible for conditioning the east side of the hallway, and the other unit is responsible conditioning for the west side of the hallway (simultaneous heating/cooling). The guests had access to the thermostats to control these units, and it was commonly seen where half of the hallway was set to cool the area and the other half was set to heat the area. Recently, locked casings were installed over the thermostats to limit guest access. Now the two units servicing each hallway are set to the same mode (either cooling or heating). One building uses a mini split heat pump to condition the break room/laundry area. This equipment was installed after the BOC program certification, but it was unknown what type of equipment it replaced. The hot water is supplied for each building using three A.O. Smith boilers (a total of six boilers for the entire site) with a capacity of 100 gallons and 400,000 Btuh for each boiler. The hot water supply temperature was measured at the faucet resulting in 120°F. The boilers have been scheduled based on the return temperature. If the temperature is too cold, all heaters are on. Peak periods for hot water demand are in the mornings and evenings. One additional boiler is used for laundry services. This boiler is not scheduled and is on 24 hours a day. Additionally, 127 faucet aerators have been installed on bathroom and kitchen faucet fixtures. Water flow was reduced by 1 gpm (replaced 2 gpm with 1 gpm aerators) for each fixture. The kitchen and bathroom aerators are the same piece of equipment, so flow rates do not vary. 127 low-flow showerheads have been installed, reducing the flow rate from 2.5 gpm to 1.6 gpm. It was seen that the two-bedroom suites have two showerheads per room, where all others (studios and one-bedrooms) have one showerhead. Lighting retrofits took place in a number of suites replacing overhead lighting, task lighting, and the installation of occupancy sensors. Common area hallways had a ballast replacement, and stairwell T8s were replaced with reduced-wattage T8s. An LED pool light was installed, and a timer is now used to control the pool light hours.

2107 – EXECUTIVE SUMMARY
Site 2107 indicated that they had implemented 10 measures. We were able to confirm that seven lighting, three water heating, and two HVAC measures were installed.

2107 - ATTRIBUTION SUMMARY
The facility director used the BOC program to learn about energy-efficient measures he could implement in his facility. He found it extremely helpful, and has been doing a lot to help his facility save energy. He has been implementing measures incrementally, by introducing these changes to his facility gradually. This has shown management that the training was beneficial, and that there is a lot of potential for decreasing energy consumption. More projects are planned in the future as a result of the BOC program.

2140 and 2369 – EXECUTIVE SUMMARY
Site 2140 is a college campus. It contains a wide range of buildings, most of them being served by the central plant. The central plant uses two 1,200-ton absorption chillers (one of which is currently inoperable) to provide chilled water throughout the campus. Because one of the chillers is down, facilities informed us that they have trouble maintaining a static chilled water setpoint of 44°F. With this in mind, the chilled water rises up to 50°F on a design cooling day, when most of the campus requires cooling. The hot water loop is served by a CleaverBrooks 10MMBH natural gas boiler. The hot water loop supply temperature is 180°F. Most of the buildings are served by typical VAV systems, with air handlers on each floor that condition air with chilled water and hot water coils tied back to the central plant. The “small college,” or old section of campus, is conditioned by fan coil units that are located in the floors of each building. These fan coil units used to be manually controlled, meaning that when facilties staff would receive a complaint, they would come and manually open and close chilled water and hot water valves. These units were not tied to thermostats, and ran 24/7. Digital thermostats were installed and tied to these units. The fan coil units are now scheduled, and the chilled water and hot water valves modulate with demand. Buildings 1,2,3, and 4 are served by packaged RTUs (DX Cooling, Gas Pack Heat). These units also ran 24/7. By installing new thermostats, these units are now scheduled properly with occupancy overrides if necessary. Several air handlers around campus had economizers that were either fixed in a minimum position or had broken actuators. This leads to extremely inefficient operation, as the units are not able to free cool. These economizers were repaired, allowing the air handler to use outside air properly, reducing the need for mechanical conditioning. A building on campus originally had five strobic exhaust fans of varying sizes running 24/7. Even though the fans had VFDs, the bypass dampers were stuck fully open, causing the fans to run at 100% to chase a differential setpoint that they could not meet. The pneumatic controls for these dampers were replaced, and the dampers are now closed. With this measure, the fans are now able to turn off, and can modulate to 50% speed when needed. The Make Up Air Unit serving the VAV system there also has a chilled water valve that is broken, and currently stuck at 30% open. There are plans to replace this valve in the next three months. Lighting measures were installed in five different buildings. These lighting measures included complete fixture retrofits, installation of lighting controls, and delamping. A total of five different measures were implemented throughout the five buildings, where in some cases the same lighting measures were implemented in different buildings. The facility operator has been enthusiastic about saving energy, and has been testing out lighting controls throughout the buildings, offices, and classrooms. This facility also had the EMS system set up to monitor lighting use and reduction from lighting controls. It also included the percent of savings acquired since the installation of lighting upgrades. Site 2140 indicated that they had implemented 52 measures. We were able to confirm that they had implemented 10 HVAC measures and five lighting measures. Some of the measures they indicated were implemented prior to the BOC program, and some were not

2140 and 2369 – EXECUTIVE SUMMARY
implemented, as the participant may have "misclicked" or mislabeled a measure. Note that site 2140 and 2369 are the same site, but were issued two different site IDs, as two of the staff have been through the BOC program. Each certified member participated in the survey and was issued their own site ID. However, savings for both site IDs are identical, as the site is the same for each. The savings were captured under Site ID 2140, but while onsite we gathered information from both BOC program participants.

2140 and 2369 – ATTRIBUTION SUMMARY
The facility director used the BOC program to train his technicians to be more aware of energy efficiency measures. He said the BOC program was extremely useful in helping them understand what they were doing, as well as why they were implementing certain projects. He took the course to make sure that it was valuable for his team. He said that the BOC program was extremely helpful in helping develop his team's knowledge base, but did not necessarily impact the measures that he has been implementing since he participated in the BOC program.

2162 – EXECUTIVE SUMMARY
Site 2162 is a theater that is approximately 50,000 square-feet in size. The only upgrades to this facility were lighting measures. All lighting measures were upgraded to LEDs. A lighting retrofit that removed T8 linear fluorescent and replaced them with LED tubes has potential for hundreds of additional fixture replacements. These replacements are planned for the future, but are not yet implemented (except for the one fixture accounted for in our savings calculations). Site 2162 indicated that they had implemented one type of lighting measure. We were able to confirm that two lighting measures were installed.

2162 – ATTRIBUTION SUMMARY
The facility manager at this site indicated that while many of the lighting measures were planned, the BOC program helped him understand more about HVAC. The information learned helped him see that making changes to their HVAC system could save energy. However, the site does not currently have a sufficient budget to make changes to the HVAC system.

2175 – EXECUTIVE SUMMARY

Site 2175 is a city hall building. It is comprised of a mixture of office spaces, tenant spaces, two theaters, and a parking garage. The building has a central plant that contains three chillers and two boilers. The chilled water loop also had an ice builder, but it has been decommissioned due to maintenance issues. Chiller 1 has a VFD that modulates compressor motor speed with load. Chiller 2 is constant speed. Chiller 3 is redundant and is only used if Chillers 1 and 2 fail, or if one chiller fails on design day.

The building is conditioned by 14 air handlers that are tied to the central loop. These units used to run 24/7, with no setbacks implemented. As a result of the BOC program, they have scheduled most of the AHUs to run from 5:30 a.m. to 12 a.m. Although 12 a.m. is generally a late stop time, they keep the spaces conditioned for events, meetings, and employees that work late during the week. The AHUs serving the theater are now turned on one to two hours prior to a show and off one to two hours afterward. The AHUs serving conference rooms now operate off of new thermostats, which turn the AHU on for four hours. Facilities staff indicated that the AHUs run on average eight hours a day.

Lighting measures were identified for five different sites: (1) city hall office spaces, hallways, and a large theater; 2) preschool/daycare center; 3) offices; 4) teen center; 5) senior center). The survey limits the number of sites to three, therefore the additional two sites were unknown until the site visit. Square-footage was collected from the mechanical plans for each site, and lighting savings per square-foot were calculated based on these areas. Many different lighting projects were implemented, including delamping, fixture retrofits, lighting controls, and even switching the circuit breaker completely off for certain maintenance hall lighting.

The survey indicated that 13 scheduling measures were implemented. In reality, they had only scheduled their AHUs at Site 1. Site 2 had no HVAC measures implemented in the past four years. The survey also indicated seven lighting measures for Site 1, where nine measures were verified onsite. Seven lighting measures were identified in the survey and onsite for Site 2. The survey did not indicate any lighting measures for Site 3, however one lighting measure was verified while onsite. The two new sites (Site 4 and Site 5) each had two lighting measures implemented. A total of 21 lighting measures were installed as a result of the BOC program.

2175 – ATTRIBUTION SUMMARY

The BOC program heavily influenced lighting projects at this site. The participant was very proactive about energy-efficient lighting, and seemed to be knowledgeable as well. The BOC program also influenced the scheduling of the AHUs.

2175 – EXECUTIVE SUMMARY

2199 – EXECUTIVE SUMMARY
This site is an adult rec center. They just recently replaced their existing packaged AC units. These older units had constant-speed fans and economizer dampers that were fixed in a minimum position for ventilation. The ducting was extremely convoluted. As duct sealing began to fail, it was extremely hard for the facility staff to identify and reseal leaks in the ductwork. Before the AC unit replacement and re-ducting, they estimated that 15% of conditioned air was being wasted due to leaks. This site has also conducted several lighting projects, with most of the lighting having been replaced in the past year. They also installed low-flow faucets in the bathrooms and pre-rinse spray valves in the kitchen.
2199 – ATTRIBUTION SUMMARY
The technician that took the training said that he greatly benefitted from the BOC program. He learned about lighting efficiency measures, which inspired him to push for lighting retrofits at the building. The AC units that were replaced were nearing their end of life, but their currently efficient operation was influenced by the BOC program.

2242 – EXECUTIVE SUMMARY
The central plant at this campus was retrofitted with new boilers, chillers, pumps, cooling towers, and a new storage tank four years ago. The college is planning on performing extensive retro-commissioning (RCx) on this central plant in the coming year. Most of the measures indicated on the survey were associated with this upcoming RCx project, or the central plant that was installed before the participant enrolled in the BOC program. The participant has upgraded their Math building with new BACnet controllers. These controllers have allowed their equipment to operate more efficiently. They also repaired the economizers at the AHUs, which were originally fixed at a minimum position. The print shop in this building has been repurposed, and no longer requires 100% outside air ventilation. Last year, facilities retrofitted this Make Up Air (MUA) Unit, AHU-3, with return ducting and a functional economizer. Lastly, the campus also installed a VFD on their pool pump. This pool pump has significant run hours, and has saved a tremendous amount of energy in the past year. While onsite, we were told that numerous lighting projects have been implemented throughout the campus, but that there was no existing record of these projects. We were able to capture savings for one project that replaced parking lot lighting with LEDs. The lighting upgrade was made to only one parking lot, but there are plans in the future to upgrade lighting for all of the parking lots on campus. We were unable to verify any other lighting measures on campus, as the electrician was contacted later in the day and was unable to provide us with additional information about lighting upgrades. These measures have been noted as "unknown" as to whether they were implemented or not. However, we learned the electrician is the one responsible for the lighting upgrades and is not BOC program-certified. The participant is very driven in pursuing energy-saving projects, and is using BOC program training as a means to educate their technicians and facility managers to identify and pursue energy-saving projects.

2242 – ATTRIBUTION SUMMARY
The facilities director that participated in the BOC program was not able to provide us with much information on the site's projects. He said the training was beneficial to him, but did not directly impact specific projects. Most of the projects that he indicated on the survey were future projects that the site plans to implement in the next couple of years. The central plant desperately needs to be commissioned, which is their main focus right now.

2311 – EXECUTIVE SUMMARY
Site 2311 is a large multistory retail building. The address indicated on the survey was incorrectly given, as this site is located elsewhere. The square-footage provided in the survey is for the first location. The square-footage has been updated to reflect the second store (as it is not identical to the first location). The entire facility is conditioned by 28 split central air conditioners, where eight of them were replaced with new units of the same size (and included CO2 sensors in the return duct space), and two of them were replaced with larger-sized units. The facility is equipped with economizers, where outside air is properly being used to offset mechanical conditioning. This is something that was already being done prior to the BOC program certification. The scheduling of HVAC systems has been modified to align space conditioning with occupancy. The facility implemented five lighting measures. It was mentioned onsite that since this retailer is a large corporation, it is difficult to get funding and support for energy efficiency projects, so lighting is the most cost-effective measure that can be implemented. Since this is a very large facility, there is potential for energy savings for lighting solely. Lighting measures included complete fixture retrofits, reduced-wattage T5s, lighting controls, and even changing lighting schedules. It was found that the cleaning crew was using the merchandise lighting (halogens) along with the overhead lighting (T5s) at night. By completely shutting these lights off and using a 4,000K lamp that uses less wattage, the energy usage is decreased. The site also replaced all of their emergency exit signs with signs that use properties similar to "glow in the dark" properties, which completely eliminates energy consumption. These exit signs meet the code requirement of illumination for more than four hours, and are charged by surrounding lighting.

2311 – ATTRIBUTION SUMMARY
The facility director we met with is the supervisor of the individual who participated in the survey. The supervisor has been influenced to send all of his staff to receive the BOC program training. He currently has completed Level II of the training, where his staff has completed Level I. He is extremely enthusiastic about energy efficiency. He plans to do other energy-efficient projects, and hopes to send his staff through the Level II training soon.

2381 – EXECUTIVE SUMMARY

Site 2381 is composed of three buildings, Buildings 1 and 3 are mostly offices but also include a cafeteria, kitchen, lobbies, and restrooms. Building 2 is a lab testing facility, which was not accessible due to confidentiality reasons. Heating is provided to the buildings by two hot water CleaverBrooks 1,000MBH condensing boilers with internal extended-heating surface tubes that provide a minimum efficiency of 97%. The boilers are scheduled to be completely shut down during summer months (May through September), as this facility is located in a Hot/Dry climate. The Energy Management System (EMS) is set up to power down the boilers in the summer when outdoor air is 70˚F, and to power on the boilers when the outdoor air is 65˚F. Temperature setpoints for the boilers were unknown before the boilers were scheduled and these practices were implemented. The hot water loop supply temperature is 180˚F.

Buildings 1 and 3 are served by VAV systems, with a total of 49 VAVs with reheats and 39 VAVs that are cooling-only for each building. Due to security issues we were unable to calculate savings for Building 2, as it is unknown what types of systems were running in this building except that three chillers and three cooling towers were in place. Buildings 1 and 3 are identical, but it was conveyed that Building 2 is very different.

Most of the measures that were identified in the survey are scheduling measures for HVAC systems and components. All schedules were set to be the same. However, the schedules were extended rather than decreased, and therefore do not provide any savings. The schedules were extended as requested by staff and to accommodate occupancy. Schedules were set to 5:45 a.m. to 6 p.m., but were extended to 11 p.m. to account for the cleaning crew. As this was a request, the scheduling for these measures was not influenced by the BOC program.

Site 2381 indicated that they had implemented 45 measures. We were able to confirm that they had implemented one HVAC measure and two lighting measures. Some of the measures they indicated were implemented prior to the BOC program, and some were not implemented, as the participant indicated that the survey was very confusing. Also, the participant had difficulty understanding that our interest was in measures implemented post-BOC program training and as an influence of the training.

2381 - ATTRIBUTION SUMMARY

No comments to add about attribution for this site.

2389 – EXECUTIVE SUMMARY
Site 2389 is a used by a biopharmaceutical company. The space contains laboratories, office space, and a warehouse. There are several walk-in coolers and freezers where products and materials are stored. The survey was not filled out properly, as it indicated that the site was conditioned by heat pumps and gas packs. It also indicated that the site had implemented economizer measures as well as domestic hot water measures. In reality, this building is conditioned by a series of packaged DX cooling and gas pack rooftop units (RTUs). The facilities engineer informed us that the economizers were working properly on the packaged units, and that no economizer measures were implemented. After the BOC program, they implemented a number of lighting measures. They also replaced evaporator fan motors with electronically commutated high-efficiency motors.

2389 – ATTRIBUTION SUMMARY
The BOC program participant learned a great deal of information about lighting measures. She also was made aware of refrigeration optimization techniques, which led her to replacing the evaporator fan motors.

2513 – EXECUTIVE SUMMARY
Site 2513 is a government facility that is composed of three different buildings. Building 1 is the admin building, which is constructed of offices and conference rooms; Building 2 is composed of offices, classrooms, labs, restrooms/showers, and testing facilities; and Building 3 is a development and testing facility. Building 1 was conditioned using a 1964 dual duct constant volume system and now is a dual duct variable volume system using typical setpoints of 72°F and 74°F. There are VAV boxes for each office in Building 1 that controlled based on thermostat and occupancy. Occupants are allowed to adjust temperature settings ±4°F (which is a manual override from the building operator for special cases). HVAC scheduling was used for purging the building prior to occupancy in the morning using the economizer cycle. This was scheduled to occur at 5:30 a.m., and the chiller would come on at 8 a.m. The exhaust fan (with VFD) runs when the economizer cycle is on to maintain building static pressure. Before, the dampers were open 100% of the time; now they are set to a minimum of 7% all the time. The economizer is enthalpy-controlled. Prior to the BOC program certification (two to three years ago), the old gas boiler was replaced with a new electric Reiners boiler (five-stage) where one element was removed and the building operator is considering removing a second element. The boiler was in sync with the old air handler, and was manually disabled from May to October. Now the boiler is controlled by means of the EMS system to match the new air handler time. Piping has been completely removed and replaced. An electric boiler was installed in order to utilize power being generated from the 303kW PV farm. The decision and process of implementing the PV farm was prior to BOC certification. Building 1 also installed three electric tankless water heaters, which replaced 50-gallon gas storage water heaters used in the bathrooms and lunch area. Two air-cooled 110-ton rotary liquid Trane chillers (two-stage compressors) that are 12 years old are in place at this facility and are run alternately. The chilled water pumps are 10 hp each with an efficiency of 88.5%. The coils are cleaned every three months. The chillers provide space conditioning to Buildings 1 and 2. The air handler unit (in Building 1) has a dual filter system, where the pre-filter is changed every four to six months (when the gauge showed a pressure drop of 0.25 - 0.5). Building 3 is not air conditioned, but does require heating. Furnaces are used to heat Building 3. Building 2 has its own air handler unit and gas boiler. Low-flow showerheads were installed in the men's and women's restrooms in Building 2. The hot water is provided by means of one 40-gallon gas storage water heater dedicated for providing hot water to the men's restroom and one 50-gallon gas storage water heater for the women's restroom.

2513 – EXECUTIVE SUMMARY
The survey indicated that five lighting measures were installed. Of those five measures, we identified four lighting measures while onsite and also identified an additional four lighting measures outside those included in the survey (making a total of eight lighting measures implemented at this facility). All lighting measures were installed inside Building 1 or exterior to the buildings. Lighting measures included things such as installing lighting controls, complete fixture retrofits, and reduced-wattage lamps. Site 2513 indicated that they had implemented 34 HVAC, two domestic hot water, and five lighting measures. We were able to confirm and calculate savings for five HVAC measures, two domestic hot water measures, and eight lighting measures. Some of the measures identified in the survey were implemented prior to the BOC program, and some were implemented indirectly as part of another system.

2513 – ATTRIBUTION SUMMARY
The facility director used the BOC program to learn about other energy-efficient measures that can be implemented at his facility. He has been in this industry for more than 30 years, and mentioned that he still received valuable information and learned a lot from the training.

2533 – EXECUTIVE SUMMARY
Site 2533 is a hospital. This site recently went through an entire central plant replacement (although not because of the BOC program). The new central plant has VFD chillers, fully condensing boilers, and variable flow on the secondary chilled water and hot water loops. All of the three-way valves serving the building have been converted to two-way valves. Most of the old chilled water plant was left to serve as a redundant plant just in case the central plant shuts down. The central plant serves all of the buildings on the hospital campus. The campus is comprised of a series of buildings, estimated at a total of 90,000 square-feet. The old building on campus is served by a series of constant-volume air handlers tied to the central plant. The newer, four-story building was originally served by constant-volume units as well. Last year, these air handlers were retrofitted with variable frequency drives (VFDs).

2533 – ATTRIBUTION SUMMARY
Facilities staff provided the training to their engineers and technicians to educate them about the energy-efficient strategies that the new central plant would be using. They said it was a helpful training, and that the technicians took a lot away from it. The central plant replacement was not implemented as a result of the BOC program, rather the BOC program was taken as a result of the chiller plant replacement.

2563 – EXECUTIVE SUMMARY
Site 2563 is a large warehouse retail store. It is conditioned by 35 packaged rooftop units (RTUs). These RTUs have DX cooling and gas packs, however the building engineer informed us that the gas packs are never used. After completing BOC program Level I, the economizers on these units were fixed at a minimum position. The building has a central control system that was set up by a vendor. Each RTU has its own schedule. The store operates 7 days a week from 9 a.m. to 10 p.m. The store also contains a full restaurant with kitchen for its customers. They have recently replaced the pre-rinse spray valves with low-flow pre-rinse spray valves.

2563 – ATTRIBUTION SUMMARY
The facilities engineer said that the BOC program was helpful in learning and understanding energy efficiency measures, but stressed that many of the energy efficiency measures at the site were lead by upper management and corporate strategies.

2571 – EXECUTIVE SUMMARY
Site 2571 is a college campus. It is mainly served by steam and chilled water. The campus utilizes a large cogeneration plant that produces steam. This steam is run through heat exchangers in multiple buildings to provide hot water for space heat. The steam from the cogeneration plant is also used to produce chilled water. The chilled water plant is served by two centrifugal chillers and one absorption chiller, which runs at night (during off-peak hours) to produce 44°F chilled water. Because the absorption chiller is producing chilled water through recovered heat, this chiller is staged to come on initially before the centrifugal chillers. This chilled water is stored in two 500,000-gallon tanks, and is pumped through secondary loops to buildings as needed. One building underwent a complete controls retrofit. The building had numerous hot/cold complaints, as well as pressurization issues due to faulty VFD operation. The participant not only fixed these issues, but also implemented energy-efficient controls strategies, resulting in optimal operation of the equipment. These strategies include Supply Air Temperature Reset, VFD modulation as a function of static pressure, Demand Control Ventilation, and Economizer retrofits. That being said, the air handlers still run 24/7 with no setbacks. It was suggested that a schedule be implemented to follow the occupancy schedule of the building.

2571 – ATTRIBUTION SUMMARY
Because only one technician out of the facilities team took the training, it is hard to pinpoint the exact influence of the BOC program at this campus. He mentioned that most funding for facilities is going toward new buildings, rather than conservation or energy efficiency measures. That being said, this technician played a key role in all of the controls upgrades at the building analyzed in this evaluation. We also looked at another building on campus that was retrofitted. This building was extremely old. It was served by two small make-up air units for ventilation, radiators with hot water for heat, and window AC units that were turned on as needed. This building was gutted entirely, and new packaged AHUs were installed that were tied back to the central plant on campus. This project yielded large energy savings, but was not influenced by the BOC program. This was a project that was going to be implemented anyway, due to numerous complaints, maintenance issues, and poor operation of old equipment.

2627 – EXECUTIVE SUMMARY
Site 2627 is a hotel that has 129 guest rooms with an annual average occupancy of 80%. This facility has five gas boilers with 80% efficiency. Two boilers are used for space heating, two are dedicated for supplying domestic hot water to the guestrooms, and one is dedicated to hot water for laundry and the kitchen. The two boilers used for space heating are 100,000,000 BTUh, do not use reset, and are set to 170°F. Later, the boilers were scheduled, but this was pre-BOC program and savings were not included in this analysis. One boiler was set to lead and the other lag. The two boilers used for guest room domestic hot water are 80,000 BTUh set to a supply temperature of 140°F maximum, with a minimum reset temperature of 95°F; it is reset in the middle of the day and at night. The boiler for the laundry/kitchen is also 80,000 BTUh set to a supply temperature of 140°F maximum, with a minimum reset temperature of 100°F. Hot water is needed in the kitchen from 6 a.m. to 11 p.m., and hot water is needed for the laundry room from 11 p.m. to 6 a.m. Before the hot water usage was a 50/50 split between kitchen and laundry, but is now distributed 75/25. Cooling is provided to the building by an 11-year-old Carrier chiller (no reset) on a closed loop system with three compressors in series and a 200-ton cooling tower. A VFD was installed on the cooling tower fans. The cooling tower has two fans that are operated by one 10hp 1,800 rpm motor that is five years old with an efficiency of 89.5% for a 100% load, 89.2% efficiency for a 75% load, and 88.6% efficiency for a 50% load. Domestic hot water conservation measures were install, such as low-flow showerheads and pre-rinse spray valves. One low-flow showerhead was installed per guest room (129 total), reducing the flow rate from 2.5 gpm to 1.6 gpm. Two pre-rinse spray valves were installed, reducing the flow rate from 2.5 gpm to 1.5 gpm. Hot water is used in the kitchen from 6 a.m. to 11 p.m. (60% of time net use was applied to calculate the savings). Seven vending misers were installed, but received rebates from their utility. The incented savings were used for this analysis for all seven misers. The building operator mentioned future projects he wishes to implement soon. These upgrades will include upgrading refrigeration controllers and installing ECMs for commercial walk-in coolers and freezers. Also, 11 ceiling sensors in the pool area, fitness center, and conference rooms are planned for installation. Exterior lighting wall-packs will be replaced with LEDs. Smart sensors will be installed on the ceiling in the guest rooms to control plugs, switches, and thermostats.

2627 – ATTRIBUTION SUMMARY
The facility director was enthusiastic about the BOC program and mentioned that he learned a lot from the training. He seemed excited and very interested in the on-site visit too. While onsite he accompanied the engineer and asked questions to build upon his existing knowledge. He plans to do more projects in the near future.

B. Measures Included in Internet Survey and Those Audited

The table below shows the 103 different measures included in the Internet survey, the number stated to have been implemented by respondents, and the number of measures covered through the onsite audits. The last column indicates the percent of measures (or measure category) audited.

Table 24. Measures Stated to be Implemented and Audited

Row Labels	Not Audited	Audited	Total	% Audited
BOILER/HOT WATER/ STEAM	**77**	**20**	**97**	**21%**
HWtempreset_flag	11	3	14	21%
supplywaterreset_flag	11	2	13	15%
monpumppressure_flag	8	3	11	27%
pipeinsulation_flag	8	2	10	20%
tuneupboiler_flag	7	3	10	30%
HwpumpVFD_flag	6	1	7	14%
higheeboiler_flag	4	2	6	33%
steamtrap_flag	5		5	0%
monmakeupwater_flag	4	1	5	20%
matchboilcap_flag	4	1	5	20%
minblowdown_flag	3	1	4	25%
heatrecovery_flag	3		3	0%
condboiler_flag	2		2	0%
combfanVFD_flag	1	1	2	50%
CHILLER / CHILLED WTR SYS	**41**	**25**	**66**	**38%**
maintainopratlogs_flag	6	4	10	40%
optchillerprform_flag	5	3	8	38%
wtrtempresetbyload_flag	5	3	8	38%
insulatechilledwtrpiping_flag	4	3	7	43%
optimizechillersequ_flag	4	2	6	33%
multchiller_vs_comprs_flag	4	2	6	33%
replacechillers_flag	2	2	4	50%
monitrpumppress_flag	2	2	4	50%
usewtrsideecon_flag	2	1	3	33%
balancewtrside_flag	1	2	3	67%
thermalstoragesystems_flag	1	1	2	50%
evapcndnsrsys_flag	2		2	0%
other_chiller_flag	2		2	0%
absorptcoolingsys_flag	1		1	0%
COOL TOWER OPT	**22**	**9**	**31**	**29%**
ctowermaint_flag	6	2	8	25%
resetcondensertemp_flag	4	2	6	33%

Row Labels	Not Audited	Audited	Total	% Audited
optimizecondenser_flag	4	2	6	33%
replacectower_flag	5	1	6	17%
varspeedcndnsr_flag	3	2	5	40%
DOMESTIC HOT WATER	**41**	**16**	**57**	**28%**
lowflowfauc_flag	15	6	21	29%
tanklesswh_flag	10	1	11	9%
showerhead_flag	5	3	8	38%
prerinsevalves_flag	3	4	7	57%
dhw_other_flag	4	2	6	33%
soalrwh_flag	4		4	0%
ECONOM / VENT CONTR	**75**	**49**	**124**	**40%**
econoutdoor_flag	11	10	21	48%
repaireconomizer_flag	13	6	19	32%
naturalvent_flag	12	5	17	29%
scheduleheaters_flag	10	5	15	33%
reduceoutsideair_evc__flag	5	5	10	50%
resetsupplyairtemp_flag	5	5	10	50%
econcommision_flag	5	5	10	50%
co2baseddemand_flag	5	3	8	38%
cobasedventcontrol_flag	3	3	6	50%
nightpurgecycle_flag	4	1	5	20%
buildingpresscontrol_flag	2	1	3	33%
FAN OPT/AIR DISTR	**112**	**84**	**196**	**43%**
replacedampers_flag	9	7	16	44%
efficfilt_flag	8	5	13	38%
optsuppyfan_flag	8	5	13	38%
cleanheatexch_flag	8	5	13	38%
insulateduct_flag	6	7	13	54%
schedahusys_fan	9	3	12	25%
usevfds_fan_flag	5	7	12	58%
reduceresetduct_flag	7	5	12	42%
reduce	6	5	11	45%
sealduct_flag	6	5	11	45%
schedbldingwarm_flag	5	5	10	50%
schedahuduct_fan_flag	8	2	10	20%
balanceairside_flag	4	5	9	56%
commisionairsys_flag	3	5	8	63%
schedpoptstartsahu_fan_flag	6	1	7	14%
reduceoutsideair_fan_flag	4	3	7	43%
reducesimulheat_fan_flag	3	3	6	50%
schedexhaustfan_fan_flag	2	3	5	60%
demandcontrol_flag	3	1	4	25%

Row Labels	Not Audited	Audited	Total	% Audited
resetsupplyairtemp_fan_flag	2	2	4	50%
HVAC SCHED / SPACE TEMP	**128**	**95**	**223**	**43%**
matchahuched_flag	18	11	29	38%
schedboilers_flag	15	12	27	44%
optstartsahu_flag	12	10	22	45%
schedreturnexhaust_hvac_flag	11	10	21	48%
schedpump_hvac_flag	10	9	19	47%
reducesimulheat_hvac_flag	13	6	19	32%
schedexhaustfan_hvac_flag	10	8	18	44%
resetsupplyairtemp_hvac_flag	13	4	17	24%
shcedfanpwredvavbox_flag	8	9	17	53%
schedfanpwrdbox_flag	7	8	15	53%
schedheat_hvac_flag	8	5	13	38%
setbackspacetemp_flag	3	3	6	50%
LIGHTING	**176**	**87**	**263**	**33%**
T5orT8_flag	24	13	37	35%
occsensor_flag	24	12	36	33%
reducedT8_flag	18	13	31	42%
incanCFLtoLED_flag	17	10	27	37%
ledexit_flag	21	6	27	22%
incantoCFL_flag	16	10	26	38%
lineartoLED_flag	14	5	19	26%
daylighting_flag	11	7	18	39%
HIDtoEE_flag	11	5	16	31%
lightcontrols_flag	10	4	14	29%
Bilevel_flag	8	1	9	11%
Light_other_flag	2		2	0%
reducedT5HO_flag		1	1	100%
OTHER	**16**	**4**	**20**	**20%**
other_flag	16	4	20	20%
PKGE/SPLIT-SYS HVAC	**19**	**8**	**27**	**30%**
splithvac_flag	19	8	27	30%
WTR PUMP OPT	**24**	**10**	**34**	**29%**
usevfds_wtrp_flag	6	4	10	40%
improvechwnhwflow_flag	7	3	10	30%
schedpumps_wtrp_flag	6	1	7	14%
rdceflownincreasesysdelta_flag	3	2	5	40%
adjfreezeprot_flag	1		1	0%
trimimpeller_flag	1		1	0%
Total	**731**	**407**	**1138**	**36%**

C. MEASURES BY EQUIPMENT OR O&M

The table below indicates the measures with the evaluation team's designation of whether it was an equipment or operation & maintenance type of action. While imperfect, the designations are based on whether equipment must be purchased to take the action stated.

Measures that are Equipment based	
1	CO2 BASED DEMAND CONTL VENT
2	CO-BASED VENT CONTROL
3	DEMAND CONTROL VENTILATION
4	HOT WTR PUMP VFD(S)
5	INST DAYLGHT/PH_CELLS ON INT FIXT
6	INST LGHT CONTROL PANELS
7	INST OCCUPANCY SENSORS
8	INSTALL COMBUST FAN VFD(S)
9	INSULATE CHILLED WTR PIPING
10	INSULATE DUCTWORK
11	INSULATE STEAM AND WTR PIPING
12	LOW-FLOW FAUCETS
13	PKGE/SPLIT-SYS HVAC
14	PRE-RINSE SPRAY VALVES
15	REPAIR ECONOMIZER
16	REPAIR/REPLACE DAMPERS
17	REPL F54T5HO'S W/ REDUC WATT T5HO'S
18	REPL HID FIXT W/ EE TECH
19	REPL INCNDSC LAMPS OR CFLS W/ LEDS
20	REPL INCNDSC LAMPS W/ CFLS
21	REPL INCNDSC OR CFL EXIT SIGNS W/ LED
22	REPL LINEAR FLUOR W/ LED LGHT
23	REPL STNDRD WATT T8'S W/ REDUC WATT T8'S
24	REPL T12 FLUOR FIXTW/ T8 OR T5 LAMPS
25	REPLACE BLRS W/ EE BLRS
26	REPLACE CHILLERS W/ HE_CHILLERS
27	REPLACE OLD UNIT(S) W/ NEW HE
28	SEAL DUCTWORK
29	SHOWER HEADS
30	TANKLESS WATER HEATERS

31	THERMAL STORAGE SYSTEMS
32	USE WTR SIDE ECON
33	UTILIZE VFD FOR PUMPS
34	UTILIZE VFDS FOR FANS
35	VAR SPEED CNDNSR FANS
36	SOLAR WATER HEATING
Measures that are O&M Based	
37	BALANCE AIRSIDE SUPPLY
38	BALANCE WTR SIDE
39	BUILDING PRESS CONTROL
40	CHILLED WTR TEMP RESET BY LOAD
41	CLEAN HEAT EXCHANGERS N COILS
42	CTOWER MAINT
43	EFFIC FILTERS/ PRFRM FILTER MAINT
44	IMPROVE CHW AND HW FLOW CONT
45	MAINTAIN OPRAT LOGS
46	MATCH AHU SCHED TO SPACE OCCUP
47	MATCH BOILER CAPACITY TO LOAD
48	MEAS AND OPT CHILLER PRFORM
49	MIN BLWDN OF STEAM BLRS
50	MON MAKEUP WTR / STEAM BLRS
51	MON PUMP OPRATING PRESS
52	MONITR PUMP OPRAT PRESSR
53	NATURAL VENT INSTEAD OF COOLING
54	NIGHT PURGE CYCLE FOR PRE-COOLING
55	OPT CNDNSR WTR TEMP
56	OPT PART LOAD EFFIC W/ MULT CHILLERS OR VS_COMPRS
57	OPT SUPPLY FAN PERFORMANCE
58	OPTIMIZE CHILLER SEQU
59	OPTIMUM STARTS FOR AHU SYS_HVAC
60	RDCE FLOW BY INCREAS SYSTEM DELTA T
61	REDUCE OUTSIDE AIR VENT_EVC
62	REDUCE OUTSIDE AIR VENT_FAN
63	REDUCE SIMUL HEAT N COOL_HVAC
64	REDUCE SIMULTANEOUS HEAT N COOL_FAN
65	REDUCE VAV MIN POSITION

66	REDUCE/RESET DUCT STATIC PRESS
67	REPL STRWELL LGHT W/ BI-LEVEL FIXT W/SENS
68	RESET CNDNSR WTR TEMP
69	RESET HOT WTR SUPPLY TEMP
70	RESET SUPPLY AIR TEMP_EVC
71	RESET SUPPLY AIR TEMP_FAN
72	RESET SUPPLY AIR TEMP_HVAC
73	RESET WTR TEMP BY LOAD
74	SCHED AHU N DUCT STATIC PRESS RESET
75	SCHED AHU SYS FOR SPACE
76	SCHED BLDING WARM-UP/PRE-CL CYCLE
77	SCHED BOILERS
78	SCHED EXHAUST FANS
79	SCHED FAN-PWRED BOXES
80	SCHED FAN-PWRED/VAV BOXES
81	SCHED HEATERS_HVAC
82	SCHED OPT STARTS FOR AHU SYS_FAN
83	SCHED PUMPS_HVAC
84	SCHED PUMPS_WTRP
85	SCHED RETURN/EXHAUST FANS_FAN
86	SCHED RETURN/EXHAUST FANS_HVAC
87	SCHEDULE HEATERS
88	SET BACK SPACE TEMP (ELCT BASEBRD ONLY)_HVAC
89	TUNE UP BOILER(S)
90	USE ECON N OUTDOOR AIR CONT
Measures that contain both equipment and O&M	
91	COMMISSION AIR SYSTEMS
92	ECON COMMISSIONING
Measures that are unknown as to type	
93	DHW_OTHER
94	OTHER

D. Internet Data Collection Instrument

Introduction

On behalf of Opinion Dynamics and the California Public Utilities Commission, thank you for your time to complete this survey regarding the Building Operator Certification. According to our records, you participated in the Building Operator <LEVEL FROM SAMPLE> Certification Program in <CLASS CITY FROM SAMPLE>. We are conducting an evaluation of the program to capture any potential energy savings that occurred at your business since taking the course. The survey will take about 15 minutes.

As a token of appreciation for completing this internet survey, the BOC program is offering one (1) BOC continuing education hour towards renewal of your certification in 2014. Your help is very important.

This survey will require some detailed information. You may want to find the following information before you begin, though a close estimate is fine. Remember, you can leave the survey to find any information and return using the link in the invitation email.

- Total energy cost per year for your facilities
- Square footage of your facility (or three largest, if you oversee more than one)

If you experience any technical issues with this survey, please contact Opinion Dynamics, the company conducting this study, at BOCResearchStudy@opiniondynamics.com.

Footer: If you cannot complete the survey at one time or accidentally quit out of the survey, you can return to the survey at the last question you answered by clicking on the link from your email or hitting the back button.

Screener

S1. Do you recall participating in the BOC training program between 2010 and 2012?

1. Yes
2. No [THANK AND TERMINATE]
8. Don't know [THANK AND TERMINATE]

S2. Please describe your involvement with building operations.

1. I conduct or manage operations or maintenance activities at a facility.
2. I am unemployed
3. I am a student
00. Other, specify
8. Don't know

S3. Why did you decide to enroll in the BOC training program? [PLEASE SELECT ALL THAT APPLY]

1. To save energy/help create a more efficient facility
2. To take advantage of the partial tuition rebate
3. Career development
4. Help facility save money
5. Help create a more comfortable facility
6. Required to by employer
00. Other, specify
8. Don't know

S4. At the time that you attended the BOC training program, did you conduct or manage operations or maintenance activities at a facility?

1. Yes
2. No
8. (Don't know)

[IF S2>1]
Those are the last of my questions. Thank you very much for your time and help with this study [TERMINATE]

Attendee Characteristics

AC1. What is your title or position at your company?

1. Chief Engineer
2. Building Management Engineer
3. Facilities Manager
5. Electrician
6. Stationary Engineer
7. Maintenance Mechanic
00. Other, specify
8. Don't know

AC3. How many other employees at your facility are currently certified building operators? [NUMERIC OPEN END, 0 to 997, 998=Don't know]

AC4. Besides the BOC-related courses, have you ever attended any other courses at the Energy Training Centers in California?

1. Yes
2. No
8. Don't Know

[ASK IF AC4=1]
AC5. Which courses did you take and where? [OPEN END]

Facility Characteristics

F1. How many facility locations do you oversee?

1. 1
2. 2
3. 3
4. 4
5. 5
6. More than 5
8. Don't know

[ASK IF F1=1]
F2. Is the address of your facility [READ-IN ADDRESS FROM DATABASE]?

1. Yes

2. No
8. Don't know

[ASK IF F2=2]
F3. Can you please provide me with the address of your facility? [OPEN END; 8=DK]

[ASK IF F1=2,3,4,5 or 6]
F4. Is one of the addresses of your facilities [READ-IN ADDRESS FROM DATABASE]?
1. Yes
2. No
8. Don't know

[ASK IF F1=2,3,4 5,or 6]
F5 Please provide the addresses for up to 3 of your largest facilities. Please also include the square footage of each facility.

NOTE: Please use a physical address, not a mailing address. Your three largest facilities could be at the same mailing address, or at a separate mailing address. Here is an example of a possible list of facilities:

1. 123 Example St., Building A
2. 123 Example St., Building B
3. 345 Example St., Building A

[OPEN END; 8=DK]

Market Sector

[ASK IF F1=2,3,4,5 or 6, ELSE SKIP TO F8]
F6. Is there more than one type of business that occupies the facilities that you oversee?
1. Yes
2. No
8. Don't know

[ASK IF F6=1]
F7. What type of businesses occupy your facilities?
["-Click Here-"OPTIONS ARE THE SAME AS THOSE LISTED FOR F8]

Facility	Address	Market Sector	DK
A	<Address_1>	-Click Here-	O
B	<Address_2>	-Click Here-	O
C	<Address_3>	-Click Here-	O

[ASK IF F1=1 OR IF F6=2, 8]
F8. What type of business occupies your [IF F1=1 "facility", IF F1>1 "facilities]?
1. School/University
2. Office
3. Retail
4. Restaurant

5. Hospital/Medical
6. Grocery
7. Warehouse
8. Process Industrial
9. Other Industrial
10. Residential/Apartment Building
11. Hotel/Motel
12. Mixed Use
13. Real Estate/Property Management
14. Government
15. Corrections/Jail
16. Waste Water Treatment
00. Other, specify _______________
98. Don't know

[ASK IF F1=2, 3, 4, 5 or 6]
F10. Are all facility operating hours the same?
1. Yes
2. No

[ASK IF F1=1 OR F9a=1]
F9. How many hours per day is your site typically open for business?

Facility	Address	Typical Week Day	Saturday	Sunday
A	<Address_1>	[1-24, DK]	[1-24, DK]	[1-24, DK]

[ASK IF F1=2, 3, 4, 5 or 6 & F9a=2]

[ASK IF F10a=2]
F10_1 and F10_2. How many hours per day are your three largest facilities typically open for business? If there are multiple tenants in your facility(s), please include your best estimate overall.

	Address	Typical Week Day	Saturday	Sunday
A	<Address_1>	[1-24, DK]	[1-24, DK]	[1-24, DK]
B	<Address_2>	[1-24, DK]	[1-24, DK]	[1-24, DK]
C	<Address_3>	[1-24, DK]	[1-24, DK]	[1-24, DK]

[ASK IF ANY FACILITIES IN F7=1 OR F8=1]
F11a. Please select any months in which your educational facilities are usually closed.

1. None – The facilities(s) are active all year.
2. January
3. February
4. March
5. April
6. May
7. June
8. July

9. August
10. September
11. October
12. November
13. December

F11. Does your company own or lease your space at [**IF F1=1 ="this facility", IF F1=2,3,4,5 or 6 " these facilities"**]?

1. Owner or partial owner
2. Lease/Rent
3. Both
8. Don't know

F13. Consider the number of occupants that your [IF F1=1 "facility has, IF F1>1 & F1<4, "facilities have", IF F1>3, "largest 3 facilities have"] in a typical day. Would you say your business has…?

(NOTE: The word "occupants" does not necessarily mean employees. For example: residents in an apartment building, patients in a hospital, students in a school, etc.)

	Address	**Typical Occupants**
A	<Address_1>	[OPEN END]
B	<Address_2>	[OPEN END]
C	<Address_3>	[OPEN END]

F13b. If you don't know the precise number of typical occupants that your [IF F1=1 "facility has, IF F1>1 & F1<4, "facilities have", IF F1>3, "largest 3 facilities have"] in a typical day, please select the range that is closest.

(NOTE: The word "occupants" does not necessarily mean employees. For example: residents in an apartment building, patients in a hospital, students in a school, etc.)

	Address	**Typical Occupants**
A	<Address_1>	[DROP DOWN]
B	<Address_2>	[DROP DOWN]
C	<Address_3>	[DROP DOWN]

F13 "Typical Occupants"

1. 1-4 occupants
2. 5-9
3. 10-24
4. 25-49

5. 50-99
6. 100-249
7. 250-499
8. 500-999
9. 1,000 or more
98. Don't know

[ASK IF F1=1]
F14. What is the square footage your facility? [NUMERIC OPEN END, 500-200,000, 999998=DK]

[ASK IF F1=2,3,4,5 or 6]
F15. What is the square footage of these facilities?

Facility	Address	Square Footage	DK
A	<Address_1>	[OPEN END]	O
B	<Address_2>	[OPEN END]	O
C	<Address_3>	[OPEN END]	O

[ASK FOR DK FROM F14 OR F15]
F16. If you don't know the precise square footage, please select the range that is closest to the facility size.

Facility	Address	Under 25,000	25,001-75,000	75,001-250,000	250,001-750,000	750,001-1,000,000	Over 1,000,000	DK
A	<Address_1>	O	O	O	O	O	O	O
B	<Address_2>	O	O	O	O	O	O	O
C	<Address_3>	O	O	O	O	O	O	O

[ASK IF F1=1]
F17. What is the primary space (or HVAC system) heating fuel used in your facility(s)?
1. Gas
2. Oil
3. Electric
4. Other, specify
8. Don't know

[ASK IF F1=1]
F18. What is the primary space (or HVAC system) heating system type?
1. Central furnace
2. Room heater, wall or floorboard
3. Hot water coils (radiator loop)
4. Space heaters (Unit heaters)
5. Heat pump, air source
6. Heat pump, ground source
7. Water Loop Heat Pump
8. Boilers

00. Other, specify
98. Don’t know

[ASK IF F1=2,3,4,5 or 6]
F19. What is the primary space heating fuel and heating system type in each facility?
[“-Click Here-“OPTIONS ARE THE SAME AS THOSE LISTED FOR F17 AND F18]

Facility	Address	Heating Fuel	Heating System	DK
All	All	-Click Here-	-Click Here-	O
If heating systems are different in different buildings, use the selections below.				
A	<Address_1>	-Click Here-	-Click Here-	O
B	<Address_2>	-Click Here-	-Click Here-	O
C	<Address_3>	-Click Here-	-Click Here-	O

[ASK IF F1=1]
F20. What is the primary cooling system type at your facility?
1. Packaged unit - cooling only
2. Packaged unit – cooling and heating in the same unit
3. Chiller
4. Evaporative cooler
5. Air cooled heat pump
6. Water Loop Heat Pump
7. Geothermal heat pump
8. Window units
96. No cooling
00. Other, specify
98. Don’t know

[ASK IF F1=2,3,4,5 or 6]
F21. What is the primary cooling system type at your facilities?
[“-Click Here-“OPTIONS ARE THE SAME AS THOSE LISTED FOR F20]

Facility	Address	Cooling System	DK
All	All	-Click Here-	O
If cooling systems are different in different buildings, use the selections below.			
A	<Address_1>	-Click Here-	O
B	<Address_2>	-Click Here-	O
C	<Address_3>	-Click Here-	O

[ASK IF F1=1]
F22. What is the primary fuel used for water heating at your facility?
1. Gas
2. Electric
3. Oil

4. Solar
00. Other, specify
98. Don't know
99. Refused

[ASK IF F1=2,3,4,5 or 6]
F23. What is the primary fuel used for water heating at your facility?
["-Click Here-"OPTIONS ARE THE SAME AS THOSE LISTED FOR F22]

Facility	Address	Primary Water Heating Fuel	DK
All	All	-Click Here-	O
If cooling systems are different in different buildings, use the selections below.			
A	<Address_1>	-Click Here-	O
B	<Address_2>	-Click Here-	O
C	<Address_3>	-Click Here-	O

F25. What is your estimated total annual energy cost for all facilities (electricity and natural gas) ($/year). [NUMERIC OPEN END, UP TO 9,999,999; DK]

F26. What is your estimated total cost for <u>electricity alone</u> for all facilities ($/year). [NUMERIC OPEN END, UP TO 9,999,999; DK]

F27. What is your estimated total cost for <u>natural gas alone</u> for all facilities ($/year). [NUMERIC OPEN END, UP TO 9,999,999; DK]

F28. Since attending the BOC training, can you describe how you monitor your facilities' energy use and hourly load shape? Please describe any software tools you use for this purpose. [OPEN END]

1. [SPECIFY: OPEN END]
2. We do not monitor hourly load shape
8. Don't know

Energy Savings Actions

E0. Has your facility taken any actions or replaced any equipment **in order to save energy**, AFTER your BOC training.

1. Yes
2. No [SKIP TO E0b]

[ASK IF E0=1]
E0aa. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made AFTER your BOC training? In general would you say these are...?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings

4. Not measureable

E0a. What are the estimated energy savings from the actions you took or equipment replacement in order to save energy AFTER your BOC training as a PERCENTAGE of total energy consumed [this facility/these facilities? [ENTER % Therms and % Electricity and % Other (Specify) or Don't Know]

[ASK IF E0=2]
E0b. Please explain why you have not taken any action or replaced any equipment in order to save energy since the BOC training. [OPEN END, ANSWER THEN SKIP A4]

[ASK IF E0=1ELSE SKIP TO A4]
**E1TXT.
A list of potential energy-saving actions is provided below. Please indicate if your [IF F1=1 "facility has, IF F1>1 & F1<4, "facilities have", IF F1>3, "largest 3 facilities have"] taken any of these actions or replaced any equipment related to these categories in order to save energy, and if this action was taken BEFORE and/or AFTER your BOC training.

Please select at least one answer for each item below.

[RANDOMIZE]

Action Type	**Action Taken Before BOC**	**Action Taken After BOC**	**Action not taken**	**Don't Know**
E1a. Boiler/Hot Water/ Steam System Changes	○	○	○	○
E1b. Chiller / Chilled Water System Changes	○	○	○	○
E1c. Cooling tower optimization	○	○	○	○
E1d. Domestic Hot Water changes such as new faucets, showerheads or water heaters	○	○	○	○
E1e. Economizer and Ventilation control changes	○	○	○	○
E1f. HVAC Equipment Scheduling or Space Temperature changes	○	○	○	○
E1g. Fan optimization/Air Distribution upgrades	○	○	○	○
E1h. Lighting changes	○	○	○	○
E1i. Water Pump optimization changes	○	○	○	○
E1j. Package/Split-System HVAC Changes	○	○	○	○
E1k. OTHER changes not mentioned above	○	○	○	○

[ASK IF E1K=2]
E2. You indicated that you had taken actions to save energy that were not described on the previous list. Please tell us briefly what actions those were. [OPEN END]

[IF E1A-E1J=3, SKIP TO AA1]

Boiler/Hot Water/ Steam System Changes
[ASK IF E1A=2; ELSE SKIP TO NEXT SECTION]
B1. You mentioned that you made some boiler/hot water/steam upgrades after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

B1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to the boiler/hot water/steam? In general would you say these are…?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

B2. What are the estimated energy savings from the boiler, hot water, and/or steam upgrades as a PERCENTAGE of total energy consumed at [this facility/these facilities]? [ENTER % Therms or % Electricity or % Other (Specify) or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
B3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF "Another Facility" FROM B3a]
B3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding what actions you took to improve the boiler/hot water/steam system since participating in the BOC program.

Please select an answer for each item below.

B4. Did you…. [ROTATE LIST]	**Yes**	**No**	**DK**
B4a. Tune up boiler(s)	O	O	O
B4b. Install hot water pump VFD(s)	O	O	O
B4c. Reset the hot water supply temperature	O	O	O
B4d. Install combustion fan VFD(s)	O	O	O
B4e. Test and replace faulty steam traps	O	O	O
B4f. Reset supply water temperature based on load	O	O	O
B4g Replace conventional gas boilers with condensing boilers	O	O	O

B4h Minimize blowdown of steam boilers	O	O	O
B4i. Monitor makeup water for steam boilers	O	O	O
B4j. Monitor pump operating pressures	O	O	O
B4k. Match boiler capacity to load with multiple boilers or high turndown ratio	O	O	O
B4l. Implement heat recovery with exhaust gas heat exchanger	O	O	O
B4m. Insulate steam and water piping	O	O	O
B4n. Replace existing boilers with new high-efficiency boilers	O	O	O

[ASK IF ALL B4=NO OR DK]
B5. You indicated that you took some action to optimize your boiler/hot water/steam system. Please describe what you did. [OPEN END]

Chiller / Chilled Water System Changes
[ASK IF E1b=2; ELSE SKIP TO NEXT SECTION]
C1. You mentioned that you made some Chiller and/or Chilled Water System changes after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

C1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to the Chiller and/or Chilled Water System? In general would you say these are…?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

C2. What are the estimated energy savings from the Chiller and/or Chilled Water System Changes as a PERCENTAGE of total electricity consumed [this facility/these facilities]? [ENTER % Electricity or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
C3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF "Another Facility" FROM C3a]
C3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding what actions you took to improve the Chiller and/or Chilled Water System <u>since</u> participating in the BOC program.

Please select an answer for <u>each item</u> below.

C4. Did you…[ROTATE LIST]	Yes	No	DK
C4a. Balance water side	O	O	O
C4b. Change the chilled water temperature reset based on load	O	O	O
C4c. Optimize chiller sequencing	O	O	O
C4d. Maintain operating logs	O	O	O
C4e. Monitor pump operating pressures	O	O	O
C4f. Use water side economizer	O	O	O
C4g. Insulate chilled water piping	O	O	O
C4h. Install thermal storage systems	O	O	O
C4i. Install evaporative condenser system	O	O	O
C4j. Optimize part load efficiency with multiple chillers or variable speed compressors	O	O	O
C4k. Measure and optimize chiller performance	O	O	O
C4l. Install absorption cooling systems	O	O	O
C4m. Replace existing chillers with new high-efficiency chillers	O	O	O

[ASK IF ALL C4=NO OR DK]
C5. You indicated that you took some action to optimize your Chiller and/or Chilled Water System. Please describe what you did. [OPEN END]

Cooling tower optimization
[ASK IF E1c=2; ELSE SKIP TO NEXT SECTION]
CT1. You mentioned that you optimized your cooling tower after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

CT1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to the cooling tower? In general would you say these are…?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

CT2. What are the estimated energy savings from the cooling tower optimization as a PERCENTAGE of total electricity consumed [this facility/these facilities]? [ENTER % Electricity or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
CT3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF "Another Facility" FROM CT3a]
CT3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding what actions you took to optimize your cooling tower since participating in the BOC program.

Please select an answer for each item below.

CT4. Did you…. [ROTATE LIST]	**Yes**	**No**	**DK**
CT4a. Reset condenser water temperature	○	○	○
CT4b. Optimize condenser water temperature	○	○	○
CT4c. Cooling tower maintenance for optimum operation	○	○	○
CT4d. Use variable speed condenser fans for capacity control	○	○	○
CT4e. Replace old unit(s) with a new high-efficiency one (s)	○	○	○

[ASK IF ALL CT4=NO OR DK]
CT5. You indicated that you took some action to optimize your cooling tower. Please describe what you did. [OPEN END]

Domestic Hot Water Changes
[ASK IF E1d=2; ELSE SKIP TO NEXT SECTION]
DH1. You mentioned that you made some domestic hot water changes after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

DH1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to the domestic hot water? In general would you say these are…?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

DH2. What are the estimated energy savings from the domestic hot water changes as a PERCENTAGE of total energy consumed [this facility/these facilities]? [ENTER % Therms or % Electricity or % Other (Specify) or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
DH3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF "Another Facility" FROM DH3a]
DH3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding the domestic hot water changes you made since participating in the BOC program.

Please select an answer for each item below.

DH4. Did you… [ROTATE LIST]	Yes	No	DK
DH4a. Install low-flow faucets	O	O	O
DH4b. Install shower heads	O	O	O
DH4c. Install pre-rinse spray valves	O	O	O
DH4d. Install tankless water heaters	O	O	O
DH4e. Install solar water heating	O	O	O

[ASK IF ALL DH4=NO OR DK]
DH5. You indicated that you took some domestic hot water saving actions. Please describe what you did. [OPEN END]

Economizer and Ventilation Control Changes
[ASK IF E1e=2L; ELSE SKIP TO NEXT SECTION]
EV1. You mentioned that made some Economizer and Ventilation Control changes after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

EV1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to the Economizer and Ventilation Controls? In general would you say these are…?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

EV2. What are the estimated energy savings from the Economizer and Ventilation Control changes as a PERCENTAGE of total energy consumed [this facility/these facilities]? [ENTER % Therms and % Electricity and/or % Other (Specify) or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
EV3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF "Another Facility" FROM EV3a]
EV3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding the Economizer and Ventilation Control changes you made since participating in the BOC program.

Please select an answer for each item below.

EV4. Did you... [ROTATE LIST]	**Yes**	**No**	**DK**
Ev4a. Install CO-based ventilation control	O	O	O
Ev4b. Install CO2 based Demand control ventilation	O	O	O
EV4c. Use economizer and outdoor air control	O	O	O
EV4d. Reduce outside air ventilation	O	O	O
EV4e. Repair economizer	O	O	O
EV4f. Schedule heaters	O	O	O
[IF ES4k=1 or FA4n=1, SKIP TO EV4h] EV4g. Reset supply air temperature	O	O	O
EV4h. Use natural ventilation instead of cooling	O	O	O
EV4i. Install building pressurization control	O	O	O
EV4j. Perform night purge cycle for pre-cooling	O	O	O
EV4k. Perform economizer commissioning	O	O	O
EV4l. Install heat recovery systems	O	O	O

[ASK IF ALL EV4=NO OR DK]
EV5. You indicated that you made some Economizer and Ventilation Control changes. Please describe what you did. [OPEN END]

[ASK IF E1f=2; ELSE SKIP TO NEXT SECTION]
HVAC System Equipment Scheduling or Space Temperature Changes
ES1. You mentioned that you made some Equipment Scheduling changes after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

EV1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to Equipment Scheduling? In general would you say these are...?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

ES2. What are the estimated energy savings from the HVAC System Equipment Scheduling or Space Temperature changes as a PERCENTAGE of total energy consumed [this facility/these facilities]? [ENTER % Therms or % Electricity or % Other (Specify) or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
ES3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF NONE FROM ES3a]
ES3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding the HVAC System Equipment Scheduling or Space Temperature changes you made since participating in the BOC program.

Please select an answer for each item below.

ES4. Did you…[ROTATE LIST]	Yes	No	DK
[IF FA4f=1, SKIP TO ES4b] ES4a. Schedule optimum starts for AHU system	O	O	O
ES4b. Match AHU schedule to space occupancy	O	O	O
ES4c. Schedule boilers	O	O	O
ES4d. Schedule exhaust fans	O	O	O
ES4e. Schedule fan-powered boxes	O	O	O
ES4f. Schedule fan-powered/VAV boxes	O	O	O
[IF EV4f=1, SKIP TO ES4h] ES4g. Schedule heaters	O	O	O
[IF P4e=1, SKIP TO ES4i] ES4h. Schedule pumps	O	O	O
[IF FA4m=1, SKIP TO ES4j] ES4i. Schedule return/exhaust fans	O	O	O
ES4j. Set back space temperature (electric baseboard only)	O	O	O
[IF EV4g=1 or FA4n=1, SKIP TO ES4l] ES4k. Reset supply air temperature	O	O	O
[IF FA4g=2, SKIP to NEXT] ES4l. Reduce simultaneous heating and cooling	O	O	O

[ASK IF ALL ES4=NO OR DK]
ES5. You indicated that you made some equipment schedule changes. Please describe what you did. [OPEN END]

[ASK IF E1g=2; ELSE SKIP TO NEXT SECTION]
Fan optimization/Air Distribution Upgrades
FA1. You mentioned that you made some Fan optimization/Air Distribution upgrades after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

FA1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to Fan optimization/Air Distribution? In general would you say these are...?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

FA2. What are the estimated energy savings from the Fan optimization/Air Distribution upgrades as a PERCENTAGE of total energy consumed [this facility/these facilities]? [ENTER % Therms and % Electricity and/or % Other (Specify) or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
FA3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF NONE FROM FA3a]
FA3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding the Fan optimization/Air Distribution upgrades you made <u>since</u> participating in the BOC program.

Please select an answer for <u>each item</u> below.

FA4. Did you...	**Yes**	**No**	**DK/REF**
FA4a. Balance airside supply	○	○	○
FA4b. Install Demand control ventilation	○	○	○
FA4c. Reduce/reset duct static pressure	○	○	○
FA4d. Install efficient filters/ perform filter maintenance	○	○	○
FA4e. Optimize supply fan performance	○	○	○
[IF ES4a=1, SKIP TO FA4g] FA4f. Schedule optimum starts for AHU system	○	○	○
[IF ES4l=1, SKIP TO FA4h] FA4g. Reduce simultaneous heating and cooling	○	○	○
FA4h. Reduce VAV minimum position	○	○	○

FA4i. Reduce outside air ventilation	O	O	O
FA4j. Repair/replace dampers	O	O	O
FA4k. Schedule AHU and duct static pressure reset	O	O	O
FA4l. Schedule AHU system for space	O	O	O
[IF ES4i=1, SKIP TO FA4n] FA4m. Schedule return/exhaust fans	O	O	O
[IF ES4k=1 or EV4g =1, SKIP TO FA4o] FA4n. Reset supply air temperature	O	O	O
FA4o. Utilize VFDs for fans	O	O	O
FA4p. Clean heat exchangers and coils	O	O	O
FA4q. Commission air systems	O	O	O
FA4r. Seal ductwork	O	O	O
FA4s. Insulate ductwork	O	O	O
FA4t. Schedule building warm-up or pre-cooling cycle	O	O	O

[ASK IF ALL FA4=NO OR DK]
FA5. You indicated that you made some upgrades. Please describe what you did. [OPEN END]

Lighting Upgrades

[ASK IF E1H=Yes, ELSE SKIP TO NEXT SECTION]
LTXT. Now I have some specific questions regarding what actions you took to improve the lighting since participating in the BOC program.

LS1. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

LS1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to lighting? In general would you say these are...?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

LS2. What are the estimated energy savings from the lighting upgrades as a PERCENTAGE of total electricity consumed [this facility/these facilities]? [ENTER % Electricity or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]

LS3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF NONE FROM LS3a]
LS3b. What is the address of the facility where you did this project?

L1. Now I have some specific questions regarding the lighting upgrades you made since participating in the BOC program.

Please select an answer for each item below.

Did you… [ROTATE LIST]	**Yes**	**No**	**DK**
L1a. Install occupancy sensors	O	O	O
L1c. Install daylighting/photocells on interior fixtures (skylights/window walls)	O	O	O
L1d. Install lighting control panels (sweep/timers)	O	O	O
L1e. Replace T12 fluorescent fixtures with T8 or T5 lamps	O	O	O
L1f. Replace linear fluorescents with LED lighting	O	O	O
L1g. Replace HID fixtures with EE technology	O	O	O
L1h. Replace standard wattage T8's with reduced wattage T8's	O	O	O
L1i. Replace F54T5HO's with reduced wattage T5HO's	O	O	O
L1j. Replace incandescent or CFL exit signs with LED	O	O	O
L1k. Replace incandescent lamps with CFLs	O	O	O
L1l. Replace incandescent lamps or CFLs with LEDs	O	O	O
L1m. Replace stairwell lights with bi-level fixture w/sensor	O	O	O

[ASK IF ANY L1E-L1I = "Yes", SHOW ONE TABLE FOR EACH ACTION TYPE L1E-L1I]
L2. You indicated that you <LIGHTING TYPE FROM L1> at your facility. Please use the pull down menus below to indicate the configuration of your old lighting and your new lighting. If you replaced or installed multiple fixtures types, please provide the information for the top three most common ones.

[IF F1=2, 3, 4, 5 or 6: Please include figures from all facilities you manage.]
[LOOP THROUGH UP TO THREE TIMES, AFTER EACH SERIES ASK "DID YOU REPLACE OR INSTALL ANOTHER TYPE OF FIXTURE?" IF YES, LOOP]

Original Configuration	Item	Current Configuration
-Click Here-	Lamp Type	-Click Here-
-Click Here-	Ballast	-Click Here-
-Click Here-	Lamp Length	-Click Here-
-Click Here-	Watts per Lamp	-Click Here-
[Numeric Open End]	Number of lamps per fixture	[Numeric Open End]
[Numeric Open End]	Number of Fixtures	[Numeric Open End]

[THE FOLLOWING ARE LISTS OF VALUES THAT SHOULD POPULATE THE "-Click Here-"DROP DOWN MENUES IN L2]

L2A "Original Lamp Type"
01 "T5"
02 "T5 High Output"
03 "T8 Standard"
04 Reduced Watt T8
05 "Super T8"
06 "T8 High-Performance (HPT8)"
07 "T8 High Output"
08 "T8 Very High Output"
9 "T10"
10 "T12 Standard"
11 "T12 High Output"
12 "Metal halide"
13 "Mercury vapor"
14 "High pressure sodium"
15 "Low pressure sodium"
16 "Pulse start metal halide"
17 "Traditional halogen"
18 "Halogen infra-red (IR)"
19 "Reflector lamp"
20 "Ceramic metal halide"
21 "Probe start ceramic metal halide"
22 "Light emitting diodes (LEDs)"
97 "Other"
98 "(Don't know)"

L2B "Current Lamp Type"
01 "T5"
02 "T5 High Output"
03 "T8 Standard"
04 Reduced Watt T8
05 "Super T8"
06 "T8 High-Performance (HPT8)"
07 "T8 High Output"
08 "T8 Very High Output"
9 "T10"
10 "T12 Standard"
11 "T12 High Output"
12 "Metal halide"
13 "Mercury vapor"
14 "High pressure sodium"
15 "Low pressure sodium"
16 "Pulse start metal halide"
17 "Traditional halogen"
18 "Halogen infra-red (IR)"
19 "Reflector lamp"
20 "Ceramic metal halide"
21 "Probe start ceramic metal halide"

22 "Light emitting diodes (LEDs)"
97 "Other"
98 "(Don't know)"

L2C "Original Ballast"
01 "Magnetic"
02 "Electronic (generic)"
03 "Electronic (high efficiency)"
04 "Dimming electronic"
05 "Programmed start"
06 "Pulse start"
97 "(Other)"
98 "(Don't know)"

L2D "Current Ballast"
01 "Magnetic"
02 "Electronic (generic)"
03 "Electronic (high efficiency)"
04 "Dimming Electronic"
05 "Programmed start"
06 "Pulse start"
97 "(other)"
98 "(Don't know)"

L2E "Original Lamp Length"
01 "1.5 Feet"
02 "2 Feet"
03 "4 Feet"
04 "8 Feet"
05 "U-Tube"
97 "(Other)"
98 "(Don't Know)"

L2F "Current Lamp Length"
01 "1.5 Feet"
02 "2 Feet"
03 "4 Feet"
04 "8 Feet"
05 "U-Tube"
97 "(Other)"
98 "(Don't Know)"

L2G "Original Watts per Lamp"
9998 "(Don't Know)"
99

L2H "Current Watts per Lamp"
9998 "(Don't Know)"
99

L2I "Original # of Lamps per Fixture"

01 "1"
02 "2"
03 "3"
04 "4"
05 "5"
97 "(Other)"
98 "(Don't Know)"

L2J "Current # of Lamps per Fixture"
01 "1"
02 "2"
03 "3"
04 "4"
05 "5"
97 "(Other)"
98 "(Don't Know)"

L2K "Original Number of Fixtures"
98 "(Don't Know)"

L2L "Current Number of Fixtures"
98 "(Don't Know)"

[ASK IF ANY L1E-L1I = "Yes"]
L2M. Approximately how much of your facility area (square feet) is lit by the lighting you just described? An estimate is fine. [NUMERIC OPEN END, 500-200,000, 999998=DK]

[ASK IF L1a="Yes"]
L3. You indicated that you installed occupancy sensors at your facility. If you installed sensors on multiple fixtures types, please provide the information for the most common one.

[IF F1=2,3,4,5 or 6: Please include figures from all facilities you manage.]

MA16. Approximately how many occupancy sensors did you install? An estimate is fine. [NUMERIC OPEN END]

MA17. Approximately how many watts are controlled by the new occupancy sensors? An estimate is fine. [NUMERIC OPEN END]

[ASK IF (MA17=0 OR 9998)]
MA17a. Approximately how many fixtures are controlled by the new occupancy sensors? An estimate is fine. [NUMERIC OPEN END]

MA17b. What is the wattage of the most common type of fixture controlled by the new lighting controls? An estimate is fine. [OPEN END]

[ASK IF (MA17b=0 OR 9998) ELSE SKIP TO MA18]
MA17c. What is the most common light fixture type controlled by the lighting controls you installed?

1. Linear Fluorescent Tube Lights

2. Incandescent Lighting
3. CFL
4. Other, specify

[ASK MA17c2 and MA17D IF MA17c=1]
MA17c2. How many lamps per fixture are there, on average, for the linear fluorescent lights?

[IF MA17c=1]
MA17d. What [is the lamp type/are the lamp types]?
1. T12
2. T8
3. T5

MA18. Approximately how much of your building area (square feet) is lit by fixtures controlled by the new lighting controls you installed? An estimate is fine.
[NUMERIC OPEN END, 0-99999]

[ASK IF L1c="Yes"]
L4. You indicated that you installed photocells on interior fixtures at your facility. Please use the pull down menus below to indicate the configuration of these photocells. If you installed sensors on multiple fixture types, please provide the information for the most common one.

[IF F1=2,3,4,5 or 6: Please include figures from all facilities you manage.]

Item	Current Configuration
Fixture Type	-Click Here-
Total Number of Fixtures with photocells	-Click Here-
Hours Off Daily - Typical	[Numeric Open End]
Manual Switch?	[Yes/No]

[THE FOLLOWING ARE LISTS OF VALUES THAT SHOULD POPULATE THE "-Click Here-"DROP DOWN MENUES IN L4]

L4A
01 "Linear Fluorescent Tube Lighting"
02 "Exit Signs"
03 "High Bay Lighting"
04 "Incandescent"
97 "(Other)"
98 "(Don't Know)"

L4B "Number of Fixtures with photocells"
98 "Don't Know"

L4C "Hours Off Daily - Typical"
98 "Don't Know"

L4D "Manual Switch?"
01 "Yes
02 "No"
98 "Don't Know"

L4a. Approximately how much of your building area (square feet) is lit by fixtures controlled by the new photocells you installed? An estimate is fine.
[NUMERIC OPEN END, 0-99999]

[ASK IF L1d="Yes"]
L5. You indicated that you installed lighting control panels (i.e. sweep/timers) at your facility. Please use the pull down menus below to indicate the configuration of these controls. If you installed controls on various multiple fixture types, please provide the information for the most common one.

[IF F1=2,3,4,5 or 6: Please include figures from all facilities you manage.]

Items on "sweep" control	Current Configuration
Fixture Type	-Click Here-
Total Number of Fixtures on sweep timer	-Click Here-
Hours Off Daily - Typical	[Numeric Open End]

[THE FOLLOWING ARE LISTS OF VALUES THAT SHOULD POPULATE THE "-Click Here-"DROP DOWN MENUES IN L5]

L5A "Fixture Type"
01 "Linear Fluorescent Tube Lighting"
02 "Exit Signs"
03 "High Bay Lighting"
04 "Incandescent"
97 "(Other)"
98 "(Don't Know)"

L5B "Number of Fixtures on sweep timer"
98 "Don't Know"

L5C "Hours Off Daily - Typical"
98 "Don't Know"

L5a. Approximately how much of your building area (square feet) is lit by fixtures controlled by the lighting control panels you installed? An estimate is fine.
[NUMERIC OPEN END, 0-99999]

[ASK IF L1m="Yes"]
L6. You indicated that you replaced stairwell lights with bi-level fixture w/sensor at your facility. Please use the pull down menus below to indicate the configuration of these lights and sensors. If you

installed sensors on multiple fixture types, please provide the information for the two most common ones.

[IF F1=2, 3, 4, 5 or 6: Please include figures from all facilities you manage.] [LOOP THROUGH TWICE MAX, AFTER EACH SERIES ASK "DID YOU INSTALL SENSORS ON ANOTHER TYPE OF FIXTURE?" IF YES, LOOP]

Items on bi-level control	Current Configuration
Lamp Type	-Click Here-
Ballast	-Click Here-
Lamp Length	-Click Here-
Watts per Lamp	-Click Here-
Number of lamps per fixture	[Numeric Open End]
Total Number of Fixtures	[Numeric Open End]
Reduction %	-Click Here-
Hours operational per Week	[Numeric Open End]

[THE FOLLOWING ARE LISTS OF VALUES THAT SHOULD POPULATE THE "-Click Here-"DROP DOWN MENUES IN L6]

L6A "Lamp Type"
01 "T5"
02 "T5 High Output"
03 "T8 Standard"
04 Reduced Watt T8
05 "Super T8"
06 "T8 High-Performance (HPT8)"
07 "T8 High Output"
08 "T8 Very High Output"
9 "T10"
10 "T12 Standard"
11 "T12 High Output"
12 "Metal halide"
13 "Mercury vapor"
14 "High pressure sodium"
15 "Low pressure sodium"
16 "Pulse start metal halide"
17 "Traditional halogen"
18 "Halogen infra-red (IR)"
19 "Reflector lamp"
20 "Ceramic metal halide"
21 "Probe start ceramic metal halide"
22 "Light emitting diodes (LEDs)"
97 "Other"
98 "(Don't know)"

L6B "Ballast"
01 "Magnetic"
02 "Electronic (generic)"
03 "Electronic (high efficiency)"
04 "Dimming electronic"
05 "Programmed start"
06 "Pulse start"
97 "(Other)"
98 "(Don't know)"

L6C "Lamp Length"
01 "1.5 Feet"
02 "2 Feet"
03 "4 Feet"
04 "8 Feet"
05 "U-Tube"
97 "(Other)"
98 "(Don't Know)"

L6D "Watts per Lamp"
9998 "(Don't Know)"

L6E "# of Lamps per Fixture"
01 "1"
02 "2"
03 "3"
04 "4"
05 "5"
97 "(Other)"
98 "(Don't Know)"

L6F "Number of Fixtures"
98 "(Don't Know)"

L6G "Reduction %"
998 "(Don't Know)"

L6H "Hours operational per Week"
998 "(Don't Know)"

L6a. Approximately how much of your building area (square feet) is lit by the new bi-level fixture w/sensors that you installed? An estimate is fine.
[NUMERIC OPEN END, 0-99999]

[ASK IF ALL L1=NO OR DK]
L7. You indicated that you made some lighting upgrades. Please describe what you did. [OPEN END]

Water Pump Optimization Changes
[ASK IF E1i=2; SKIP TO NEXT SECTION]

P1. You mentioned that you made some Water Pump Optimization changes after taking the BOC training. Did you receive a rebate from your utility for these actions?

1. Yes
2. No
8. Don't know

P1a. In your opinion, how would you characterize the energy savings at [this facility/these facilities] as a result of changes or enhancements you have made to Water Pump Optimization? In general would you say these are…?

1. Significant energy savings
2. Moderate energy savings
3. Measurable but insignificant energy savings
4. Not measureable

P2. What are the estimated energy savings from the pump optimization changes as a PERCENTAGE of total energy consumed [this facility/these facilities]? [ENTER % Therms or % Electricity or % Other (Specify) or Don't Know]

[ASK IF OVERSEE MORE THAN ONE FACILITY]
P3a. At which of the following addresses did you do this project? [READ IN ADDRESSES]

[ASK IF NONE FROM P3a]
P3b. What is the address of the facility where you did this project?

Now I have some specific questions regarding the pump optimization changes you made <u>since</u> participating in the BOC program.

Please select an answer for <u>each item</u> below.

P4. Did you…[ROTATE LIST]	**Yes**	**No**	**DK/REF**
P4a. Adjust the freeze protection sequence for pumps	O	O	O
P4b. Trim the impeller	O	O	O
P4c. Improve CHW and HW flow control	O	O	O
P4d. Reduce flow by increasing system Delta T	O	O	O
[IF ES4h=1, SKIP TO P4f] P4e. Schedule pumps	O	O	O
P4f. Utilize VFD for pumps	O	O	O

[ASK IF ALL P4=NO OR DK]
P5. You indicated that you made some pump optimization changes. Please describe what you did. [OPEN END]

Attribution

AA1. What do you feel is the most important skill or topic that you learned in the BOC training courses? [OPEN END; 8=DK, 9=Ref]

[ASK IF ANY E1TXT=2; ELSE SKIP TO QA4 AND THEN NEXT SECTION]
A1. Please consider the following list of actions that you said you have taken after your participation in the BOC training program. For each of these actions, would you have taken the same action if you had not attended BOC training?

Action Type	**Yes**	**Maybe**	**No**	**DK**
A1a. <Actions from E1TXT-After>	○	○	○	○
A1b. <Actions from E1TXT-After>	○	○	○	○
A1c. <Actions from E1TXT-After>	○	○	○	○
A1d. <Actions from E1TXT-After>	○	○	○	○

[ASK FOR EACH YES IN A1 series]
A2. If you had taken these actions without the training, when do you think it would have happened?

Action Type	**At the same time**	**Within 6 months**	**6 months to 1 year**	**In 1 to 2 years**	**In 2 to 3 years**	**In 3-4 years**	**Don't know**
A1a. <Actions from E1TXT-After>	○	○	○	○	○	○	○
A1b. <Actions from E1TXT-After>	○	○	○	○	○	○	○
A1c. <Actions from E1TXT-After>	○	○	○	○	○	○	○
a1d. <Actions from E1TXT-After>	○	○	○	○	○	○	○

[ASK IF E1d=AFTER OR E1h=AFTER; ELSE SKIP TO A4]
A2b. If you had taken these actions without the attending the BOC training, would you have taken more, the same, or fewer actions than you did?

Action Type	**More**	**Same Number**	**Fewer**	**Don't know**
A2a. IF E1d=AFTER THEN <Domestic Hot Water Changes>	○	○	○	○
A2b. IF E1h=AFTER THEN <Lighting Changes>	○	○	○	○

[ASK ALL]
A4. Now consider the training that you received through the BOC courses. Did the courses.... [1=YES, 2=NO, 98=DON'T KNOW]
a. Provide you with any new information
b. Move you closer to implementing efforts to save energy that you were already considering
c. Increase your knowledge of energy efficiency opportunities at your facility
d. Increase your knowledge of rebates and tax incentives available

[IF ALL **E1TXT=1,3,8 SKIP TO REC1]**
[IF E0=2, SKIP TO CLOSING]

A3. Beyond the influence of the BOC training, please consider the influence of other factors on your company's decision to take the energy saving actions that you did. For each item, please choose a number on a 10-point scale, where 1 is "very little influence" and 10 is "a great deal of influence". [1-10 SCALE, 98=DK] How much of an influence was…
a. The rate-of-return on investment
b. Reducing operating costs
c. Your company's commitment to going green or saving the environment
d. Availability of rebates and tax incentives
e. Increased comfort
f. Employee, customer or student complaints

A5. If you were given 100 points to reflect why you decided to take energy saving actions and you had to divide those **100 points** between **1) the influence of the BOC training program** and **2) all other influencing factors**, how many points would you give to the BOC training program?

[RECORD 0 to 100; 998=Don't Know; 999=Refused]

Action Type	Influence of BOC Program	Influence All Other Factors	Total Points
A1a. <Actions from E1TXT-After>	[Numeric Open End]	[Numeric Open End]	<Sum>
A1b. <Actions from E1TXT-After>	[Numeric Open End]	[Numeric Open End]	<Sum>
A1c. <Actions from E1TXT-After >	[Numeric Open End]	[Numeric Open End]	<Sum>
a1d. <Actions from E1TXT-After >	[Numeric Open End]	[Numeric Open End]	<Sum>

Recruiter for Phone Interview
[RECRUIT IF TOOK ANY ACTION]

REC1. Thank you for taking the time to help us with this research effort.

We will be continuing this effort with some participants both over the phone and with site visits to further understand how we might estimate energy savings based on the actions you took after the BOC courses.

As a token of appreciation for your help, the BOC program is offering participants the opportunity to earn additional BOC continuing education hours towards renewal of your certification in 2014. Your help is very important.

Phone Call		Site Visit
1 Education Hour		3 Education Hours

When would be the best time to call you for additional information if needed?

	Phone Call		Site Visit
Best Days of the Week			
Best Times of day			

Phone Number ______ [redacted]
Email ______
Contact Name ______
Contact Title ______

Closing

CTXT. Thank you very much for taking part in this important research!

E. Detailed Survey Results

Key Findings

Below are the key takeaways from the internet survey in terms of participant characteristics, propensity to take action post-training, types of actions taken, and training attribution.

Overall Participant Characteristics

- Based on survey results, we estimate that 80% of all BOC training participants directly manage a facility or conduct maintenance operations and are therefore are in a prime position to take energy saving action at a facility post-training.
  - The remaining participants are in maintenance-related positions (such as a plumber), administrative energy management positions, energy management consultants, students (8%), are unemployed (6%), have switched careers, manage facilities outside of CA or do not recall attending the BOC training.

Facility Manager Participant Characteristics

Data collection efforts continued with the subset (80%) of respondents who directly manage a facility or conduct maintenance operations in order to better understand the facilities they manage and the actions taken for the impact evaluation. Among these participants:

- BOC participants manage a wide variety of facilities with varying uses. The most common types of facilities that are managed by BOC participants are government (26%), schools (14%), office buildings (9%), hospitals (7%) and hotels (6%).
- On average, BOC participants have 4 employees at their organizations that have a BOC certification. However, this ranges from 1 employee to as high as 22 employees.
- One-third of BOC participants have also attended other courses at the Energy Centers throughout the state.
- Participants vary widely in terms of the number of facilities they oversee; 44% oversee one facility and 53% oversee multiple facilities. The remaining 3% did not know how many facilities they oversee.
- Most BOC participants (81%) work for businesses that own their facilities (rather than lease).
- Participants oversee a wide range of facility sizes. The square footage per facility ranges from 2,000 square foot to up to 500,000 square feet; the median is 60,000 sq. ft. In terms of occupants, facilities range from 2 occupants to up to 6,000 occupants; the median is 250 occupants per facility. As such the total annual energy cost per facility also widely ranges from as low as $23K per year to up to $4.4M per year; the median is $550K per year. The majority of energy costs (74%) are spent on electricity.

Taking Action Post-Training

- Among the 80% of participants who are facility managers or conduct maintenance operations, 73% took some type of energy saving action post-training. Overall, therefore, when looking at the total population, more than half of total participants (58%) took some of type of energy saving action post-training.

    - Among those who took action, 39% received the training in 2010, 33% in 2011 and 28% in 2012.
    - Alternatively, looking at the propensity to take action by program year, it seems as though more participants in recent years took some action post-training; 10% from 2010 took action, and this increased to 15% from 2011 and 23% from 2012. It is possible that more recent respondents have better recollection of what they did post-training.

- Amongst those who did not take any action, the most common reasons were budgetary constraints, the perception that they are already managing highly efficient buildings and there were few or no opportunities to do more, and/or they are not a decision-maker.
- Amongst facility managers who took action, the three most common actions were lighting changes (77%), HVAC Scheduling or Space Temp changes (56%), and Domestic Hot Water Changes (50%).
    - The most common lighting changes were installing occupancy sensors, replacing T12's, replacing T8's, replacing incandescents with CFLs, replacing exit signs with LEDs and replacing incandescent or CFLs with LEDs.
    - The most common HVAC scheduling or space temperature changes were matching AHU schedule to space occupancy; scheduling boilers, optimum starts for AHU system, exhaust fans, pumps and/or return/exhaust fans; and reducing simultaneous heating and cooling.
    - The most common domestic hot water changes were installing low-flow faucets, showerhead and/or tankless water heaters.
- Amongst those that took action, 29% think the actions lead to significant energy savings and another 50% think they led to moderate energy savings.
- Four in ten participants monitor their facilities' energy use and hourly load shape since the training. Most of them are using energy management tools such as METASYS or SCE's Energy Manager Tool.

We will analyze this information in more detail, and provide energy savings estimates, in our final report.

Motivations and Course Value

- When asked why participants sought a BOC certification, the most common reasons were for career development (52%), to save energy at their facility or create a more efficient facility (32%) and/or to help save money at the facility (16%).
- When asked for the most important skills or topics they learned in the course, 62% of respondents mentioned an important skill or topic while the remainder chose not to answer this question. Respondents mentioned a wide variety of skills and topics but mostly they related to learning how to maximize energy savings and increase efficiency; how to maintain equipment and why it is important; and how to track and report on energy usage.
- Further in terms of course value, amongst facility managers:
    - 97% said the course provided them with new information
    - 92% said the course increased their knowledge of energy efficiency opportunities at their facilities

- 79% said the course moved them close to implementing efforts to save energy that they were already considering
- 68% said the course increased their knowledge of rebates and tax incentives available

Attribution

In the final report, attribution and Net-to-Gross (NTG) will be determined by an algorithm involving many different questions within the survey. The results of some of these attribution questions are presented below.

- In terms of influences on facility managers' action taken post-training; the training had some influence on their actions while other influences were also in play. First respondents ranked the other influences on actions taken on a 1 to 10 scale. Reducing operating expenses, the ROI and their company's commitment to going green/saving the environment were highly influential. Then respondents were asked to allocate influence points from 0 to 100 for the BOC training versus all other influencing factors. The unweighted average points given to the BOC training were 59 points out of 100. Respondents gave points for each type of action they took, looking at the unweighted data it appears that the BOC program had the most influence (>60 points) on HVAC system changes, water pump optimization changes, HVAC scheduling or space temperature changes, and chiller/chilled water system changes. The program had the least influence (55.8 points) on lighting changes.
- We also asked respondents whether they would have taken each action at all without the BOC training. In this respect, it appears that the BOC program is having the most influence on water pump optimization changes given that 70% of people that took this action said they would NOT have done it without the BOC training. Whereas the majority of participants that made lighting changes and/or HVAC system changes said they would have taken these actions (although perhaps not at the same level of efficiency) without the BOC training.

Raw Data Tables

Overall Participant Characteristics

Table 25. BOC Participant Characteristics

BOC Attendee Facility Management Status	Internet Survey		Non-Resp		Total	
	Freq	%	Freq	%	Freq	%
Managing a facility & took action	52	58%	55	57%	107	58%
Managing a facility & did not take action	25	28%	15	16%	40	22%
Not managing a facility now/Did at time	5	6%	22	23%	27	15%
Not managing a facility now/Did not at time	5	6%	4	4%	9	5%
Managing a facility not in CA	1	1%	0	0%	1	1%

Do not recall participating in BOC	2	2%	0	0%	2	1%
Total	**90**	**100%**	**96**	**100%**	**186**	**100%**

Property Manager Participant Characteristics

Table 26. Facility Manager Job Titles (Internet Survey)

Job Title	Freq	%
Maintenance Mechanic	19	25%
Facilities Manager	15	20%
Chief Engineer	12	16%
Stationary Engineer	9	12%
Building Management Engineer	5	7%
Facilities Maintenance Technician	5	7%
Maintenance Supervisor	2	3%
Electrician	1	1%
Other	9	12%
Total	**77**	**100%** [a]

[a] Does not total to 100% due to rounding.

Table 27. Market Sector/Type of Business in Facility (Internet and Phone)

Market Sector	Internet		Non-Resp		Total	
	Freq	%	Freq	%	Freq	%
Government	15	19%	23	33%	38	26%
School/University	8	10%	12	17%	20	14%
Office	8	10%	5	7%	13	9%
Hospital/Medical	7	9%	4	6%	11	7%
Hotel/Motel	8	10%	1	1%	9	6%
Industrial	4	5%	2	3%	6	4%
Retail	2	3%	4	6%	6	4%
Laboratory	2	3%	4	6%	6	4%
Mixed Use	1	1%	5	7%	6	4%
Corrections/Jail	3	4%	-	-	3	2%

Market Sector	Internet		Non-Resp		Total	
	Freq	%	Freq	%	Freq	%
Entertainment Theatre	3	4%	-	-	3	2%
Residential/Apt Building	1	1%	2	3%	3	2%
Real Estate/Property Management	1	1%	1	1%	2	1%
Waste Water Treatment	1	1%	-	-	1	1%
Art Museum	1	1%	-	-	1	1%
College Recreation/Wellness Center	1	1%	-	-	1	1%
Other	2	3%	5	7%	7	5%
Multiple Sectors Across Facilities	9	12%	-	-	9	6%
(Refused)	-	-	2	3%	2	1%
Total	**77**	**100%**	**70**	**100%**	**147**	**100%**

Table 28. BOC Certified Employees at Facility (Internet Survey)

Number of BOC certified employees at facility (n=64)		
Mean	Min	Max
4	1	22

Table 29. CA Energy Training Centers courses (Internet Survey)

Attended CA Energy Training Centers courses	Freq	%
No	48	62%
Yes	26	34%
Don't know	3	4%
Total	**77**	**100%**

Table 30. CA Energy Training Centers courses (Internet Survey, multiple response)

(Amongst Those Who Attended Other Energy Center Courses)

Location of CA Energy Training Courses (n=26)	Freq	%
SCE Center	9	35%
SCG-ERC	7	27%
SDG&E - SDEIC	5	19%

Not specified	5	19%
PG&E Center	2	8%
Pasadena center	1	4%
SDG&E Local 501 Outreach Training	1	4%
Burbank center	1	4%
Oxnard center	1	4%

Table 31. Number of Facilities Overseen

	Internet Survey		Non-Respondents		Total	
	Freq	%	Freq	%	Freq	%
One facility	44	57%	21	30%	65	44%
Multiple facilities	31	40%	47	67%	78	53%
(Don't know)	2	3%	2	3%	4	3%
Total	**77**	**100%**	**70**	**100%**	**147**	**100%**

Table 32. Facility Ownership (Internet Survey)

Facility Ownership Status	Freq	%
Owner or partial owner	60	81%
Lease/Rent	9	10%
Both	3	2%
(Don’t know)	5	8%
Total	**77**	**100%**

Table 33. Facility Size (Internet Survey)

Facility Size	Mean	Min	Max	Median
Number of occupants on a typical day (n=111 facilities)	819	2	6000	250
Square footage of facility (n=89 facilities)	75,611	2,000	500,000	60,000

Table 34. Annual Facility Energy Cost (Internet Survey)

Facility Energy Cost Category	Mean	Min	Max	Median
Total Annual Energy Cost (n=30)	$1,028,314	$23,000	$4,418,865	$557,999
Total Annual Electricity Cost (n=30)	$ 824,312	$16,000	$3,500,000	$528,999
Total Annual Gas Cost (n=25)	$ 296,295	$ 4,115	$3,000,000	$75,000

Note: Data only reported on respondents who could give complete data on electric and gas costs.

Table 35. Annual Facility Energy Cost – Gas vs. Electric Ratio (Internet Survey)

Total Annual Energy Cost (n=25 respondents)	Total Reported by Respondents	Percent of Total
Electricity	$21,213,443	74%
Gas	$7,407,373	26%
Total	**$28,620,816**	**100%**

Note: Data only reported on respondents who could give complete data on electric and gas costs.

Actions Taken After BOC Training

Table 36. Hourly Load Shape Monitoring (Internet Survey)

"Since attending the BOC training, can you describe how you monitor your facilities' energy use and hourly load shape?"	Freq	%
We do not monitor hourly shape load and/or energy use	34	44%
Energy management tools (i.e. METASYS, SCE Energy Manager)	23	30%
Monitoring metering data	3	4%
Full-time energy management staff	1	1%
Other	4	5%
Don't Know	12	16%
Total	**77**	**100%**

Table 37. Facility Managers: Incidence of Taking Action

Incidence of Taking Any Action	Internet Survey		Non-Resp		Total	
	Freq	%	Freq	%	Freq	%
Took some action to save energy post-training	52	68%	55	79%	107	73%
Did NOT take action to save energy post-training	25	32%	15	21%	40	27%
Total	**77**	**100%**	**970**	**100%**	**147**	**100%**

Table 38. Facility Managers who Took Action by Training Year

BOC Training Year	Internet Survey Participants	Non-Respondents	Total
	(n=52)	(n=55)	(n=107)
2010	37%	42%	39%

BOC Training Year	Internet Survey Participants	Non-Respondents	Total
	(n=52)	(n=55)	(n=107)
2011	33%	33%	33%
2012	31%	25%	28%
Total	**100%**	**100%**	**100%**

Table 39. Reasons for Not Taking Action

	Internet Survey (n=25)	Non-Resp (n=15)	Total (n=40)
Budgetary restraints	32%	27%	30%
Few energy saving opportunities left	24%	40%	30%
Not a decision maker	24%	13%	20%
Don't know	4%	13%	8%
Moving to new facility	8%		5%
Still identifying what potential changes	4%		3%
Other	4%	7%	3%

Table 40. Incidence of Actions Taken After BOC Training

Action Type	# of Respondents (n=48)	% of Respondents (n=48)	Mean # of Actions per Respondent	Std. Deviation
Lighting changes	37	77%	5.1	2.7
HVAC Scheduling or Space Temp changes	27	56%	5.4	3.1
Domestic Hot Water changes	24	50%	1.9	0.7
Economizer and Ventilation control changes	21	44%	4.5	2
Fan optimization/Air Distribution upgrades	16	33%	10.3	5.3
Boiler/Hot Water/ Steam System Changes	16	33%	4.6	2.3
Chiller / Chilled Water System Changes	13	27%	5.1	3.9
Package/Split-System HVAC Changes	13	27%	1	0
OTHER changes not mentioned above	12	25%	1	0
Cooling tower optimization	11	23%	2.6	1.5

Action Type	# of Respondents (n=48)	% of Respondents (n=48)	Mean # of Actions per Respondent	Std. Deviation
Water Pump optimization changes	10	21%	2.6	1.3

Table 41. Boiler or Domestic Hot Water changes

Action Type	(n=16)
Reset the hot water supply temperature	11
Reset supply water temperature based on load	10
Tune up boiler(s)	9
Monitor pump operating pressures	8
Insulate steam and water piping	7
Replace existing boilers with new high-efficiency boilers	6
Install hot water pump VFD(s)	5
Match boiler capacity to load with multiple boilers or high turndown ratio	4
Test and replace faulty steam traps	3
Monitor makeup water for steam boilers	3
Install combustion fan VFD(s)	2
Replace conventional gas boilers with condensing boilers	2
Minimize blowdown of steam boilers	2
Implement heat recovery with exhaust gas heat exchanger	1
Other	1

Table 42. Chiller / Chilled Water System Changes

Action Type	(n=13)
Maintain operating logs	10
Change the chilled water temperature reset based on load	8
Measure and optimize chiller performance	8
Insulate chilled water piping	7
Optimize chiller sequencing	6
Optimize part load efficiency with multiple chillers or variable speed compressors	6
Monitor pump operating pressures	4
Replace existing chillers with new high-efficiency chillers	4
Balance water side	3
Use water side economizer	3

Install thermal storage systems	2
Install evaporative condenser system	2
Install absorption cooling systems	1
Other	2

Table 43. Cooling Tower Optimization

Action Type	(n=11)
Cooling tower maintenance for optimum operation	8
Reset condenser water temperature	6
Replace old unit(s) with a new high-efficiency one (s)	6
Use variable speed condenser fans for capacity control	5
Optimize condenser water temperature	1

Table 44. Domestic Hot Water changes

Action Type	(n=24)
Install low-flow faucets	16
Install shower heads	8
Install tankless water heaters	8
Install pre-rinse spray valves	5
Install solar water heating	2
Other	6

Table 45. Economizer & Ventilation Control changes

Action Type	(n=21)
Use economizer and outdoor air control	19
Repair economizer	15
Use natural ventilation instead of cooling	13
Schedule heaters	10
Reduce outside air ventilation	8
Reset supply air temperature	8
Perform economizer commissioning	7
Install CO2 based Demand control ventilation	6

Install CO-based ventilation control	4
Install building pressurization control	4
Perform night purge cycle for pre-cooling	4
Install heat recovery systems	1

Table 46. HVAC Equipment Scheduling or Space Temperature changes

Action Type	(n=27)
Match AHU schedule to space occupancy	18
Schedule boilers	18
Schedule optimum starts for AHU system	13
Schedule exhaust fans	13
Schedule pumps	13
Schedule return/exhaust fans	13
Reduce simultaneous heating and cooling	13
Schedule fan-powered/VAV boxes	12
Schedule fan-powered boxes	11
Reset supply air temperature	11
Schedule heaters	7
Set back space temperature (electric baseboard only)	4

Table 47. Fan optimization/Air Distribution upgrades

Action Type	(n=16)
Repair/replace dampers	13
Reduce/reset duct static pressure	11
Install efficient filters/ perform filter maintenance	11
Optimize supply fan performance	11
Schedule AHU system for space	11
Clean heat exchangers and coils	11
Schedule AHU and duct static pressure reset	10
Utilize VFDs for fans	10
Insulate ductwork	10
Seal ductwork	9
Reduce simultaneous heating and cooling	8
Schedule building warm-up or pre-cooling cycle	8

Action Type	(n=16)
Balance airside supply	7
Reduce outside air ventilation	7
Schedule optimum starts for AHU system	6
Commission air systems	6
Reduce VAV minimum position	5
Install Demand control ventilation	4
Schedule return/exhaust fans	4
Reset supply air temperature	3

Table 48. Lighting changes

Action Type	(n=37)
Install occupancy sensors	29
Replace T12 fluorescent fixtures with T8 or T5 lamps	24
Replace standard wattage T8's with reduced wattage T8's	22
Replace incandescent lamps with CFLs	21
Replace incandescent or CFL exit signs with LED	20
Replace incandescent lamps or CFLs with LEDs	20
Install daylighting/photocells on interior fixtures (skylights/window walls)	14
Replace linear fluorescents with LED lighting	13
Install lighting control panels (sweep/timers)	12
Replace HID fixtures with EE technology	11
Replace stairwell lights with bi-level fixture w/sensor	6
Replace F54T5HO's with reduced wattage T5HO's	1

Table 49. Water Pump optimization changes

Action Type	(n=10)
Utilize VFD for pumps	9
Improve CHW and HW flow control	7
Reduce flow by increasing system Delta T	4
Schedule pumps	4
Adjust the freeze protection sequence for pumps	1
Trim the impeller	1

Table 50. Other Action Types Taken among Internet Survey Respondents (n=17)

Other Actions
All refrigerated equipment was modified for optimal energy savings by changing fan motors out and reducing compressor run times.
UCSD and SDGE have installed photovoltaic thermo electric panels to convert solar power into electricity.
Solar water heating/ solar electrical generation.
Retrocommissioning of our central plant (currently undergoing), which resulted in calculated savings of approximately 490,000 kWh annually. This included all controls, sequence of operations, pumps, valves, VFD's, etc. undergoing investigation, calibration and repair/replacement. The incentive form SCE is significant and the annualized ROI is between 1-2 years.
Retro Commission project. Upgrade pneumatic controls to DDC.
Replace our 120 v lighting system for our pool and spa to a 12v led lighting system, install VSD pool and spa pumps. Replacing 120 v exit signs to 3v led exit signs. Retrofitting our 4lamp ceiling fixtures to 2 lamps with reflectors.
Reduction of lighting schedules for (4) parking structures. Installation of waterless urinals at 8 buildings. Installation of 1MW photovoltaic system
Photo-voltaic roof system
New central utility plant
Made adjustments on temperature settings and turned off unnecessary use of equipments. Organized a more energy efficient time scheduling for equipment activation. Retro fitted lighting throughout maintained facilities. Converted urinal stalls to waterless urinal for water conservation. Changed business hours of operation to maintain a general energy savings throughout citywide facilities. Increase standard of customer service from Maintenance staff to control unnecessary energy demands.
Lighting upgrades, boiler replacement, package unit replacement, added controls to 4 new locations
Lighting replaced roughly 1000 incandescent light to led
Insulation of spaces and equipment
Hallway and room lighting. Changing out dated PTAC's with new energy efficient ones, changing the pool light to LED, changing out our magnetic ballast with electronic ones, Changing out shower spouts that leak water.
Equipment upgrades
All refrigerated equipment was modified for optimal energy savings by changing fan motors out and reducing compressor run times.
Added controls to lighting, heating within buildings. Water saving urinals. Devices to save paper in bathrooms.

Table 51. Perceived Magnitude of Energy Savings

Perceived Savings due to Post BOC Actions	Internet Survey Respondents		Non-Respondents		Total	
	Freq	%	Freq	%	Freq	%
Significant energy savings	14	27%	17	31%	31	29%
Moderate energy savings	28	54%	25	45%	53	50%
Measurable but insignificant energy savings	6	12%	10	18%	16	15%
Not measureable	4	8%	1	2%	5	5%
(Refused)	-	-	2	4%	2	2%
Total	**52**	**100%**	**55**	**100%**	**107**	**100%**

Motivations, Value and Attribution

Table 52. Reasons for BOC Attendance – Facility Managers

Reasons for BOC Attendance (multiple response)	Internet and Phone (n=173)	
	Freq	%
Career development	90	52%
To save energy/help create a more efficient facility	55	32%
Help facility save money	28	16%
Required to by employer	28	16%
Help create a more comfortable facility	21	12%
To take advantage of the partial tuition rebate	11	6%
Other	38	22%

Table 53. Most Important Skills or Topics Learned in the BOC Courses (Internet Survey, multiple response)

Response	n=77
Provided one or more the following responses:	62%
How to maximize energy savings/ reduce usage/ increase efficiency	*26%*
HVAC efficiency	*12%*
General positive statement (provided overall knowledge/ was educational/ increased awareness, everything was important)	*12%*
Lighting efficiency	*6%*
Networking/ Identifying resources	*6%*
Maintenance/ How to maintain equipment/ Importance of maintaining equipment	*6%*
How to increase/optimize function of equipment	*5%*
Other (i.e., how to increase service; tracking and reporting building energy use; indoor air quality; demand savings)	*5%*
How to recognize financial opportunities (e.g., saving money through retrofits, ROI)	*4%*
Ease/practicality of making efficiency changes	*4%*
Provided important updates on new technologies and techniques	*4%*
Content is relevant to everyday work	*4%*
How to maintain/ increase comfort	*4%*
How everything works together	*4%*
Sustainability/Environment	*4%*
Electrical	*4%*
Importance of collecting building occupant feedback/schedules	*3%*
Other equipment-specific responses	*3%*
Not Applicable	*1%*
Did not provide a response	32%
Don't know	5%

Note: Values have been rounded to the nearest percent and may not sum to 100%.

Table 54. Ways BOC Training Affected Attendees (Internet Survey)

Did the courses… (n=77)	Yes	No	Don't Know	Total
Provide you with any new information	97%	1%	1%	100%
Increase your knowledge of energy efficiency opportunities at your facility	92%	6%	1%	100%
Move you closer to implementing efforts to save energy that you were already considering	79%	14%	6%	100%
Increase your knowledge of rebates and tax incentives available	68%	25%	8%	100%

Note: Values have been rounded to the nearest percent and may not sum to 100%.

In the final report, attribution and Net-to-Gross (NTG) will be determined by an algorithm involving many different questions within the survey. The results of some of these attribution questions are presented here to be considered as a preliminary snap-shot, not a definitive record of program influence. Results shown below are not weighted by the magnitude of the energy savings. The overall NTG ratio for the BOC program will be a weighted score.

Table 55. Influence of Non-BOC Factors on Decision to Take Actions (Internet Survey)

Non-BOC Factor	Mean*	Standard Deviation
Reducing operating costs (n=46)	8.5	1.9
The rate-of-return on investment (n=44)	7.9	2.1
Your company's commitment to going green or saving the environment (n=46)	7.3	2.2
Increased comfort (n=46)	6.8	2.8
Availability of rebates and tax incentives (n=45)	6.5	3.0
Employee, customer or student complaints (n=45)	6.1	2.9

* On a 10-point scale, where 1 is "very little influence" and 10 is "a great deal of influence"

Table 56. Program Influence on Actions Taken (Internet Survey)

Measure Type	# of Respondents	Influence of the BOC Training Program (0 to 100)	
		Mean	Std. Deviation
Package/Split-System HVAC Changes	13	64.6	28.5
Water Pump optimization changes	10	64.1	33.2
HVAC Scheduling or Space Temp changes	27	63.4	32
Chiller / Chilled Water System Changes	13	62.0	37.8
Economizer and Ventilation control changes	21	58.9	29.4
Cooling tower optimization	11	58.4	34.7
Domestic Hot Water changes	24	57.9	31.8
Boiler/Hot Water/ Steam System Changes	16	56.6	36.2
Fan optimization/Air Distribution upgrades	16	56.2	31.4
Lighting changes	37	55.8	32.8
Overall	**48**	**59.2**	**32.1**

Table 57. Whether Participants Would Have Taken Action Without Training (Internet Survey)

Action Taken	Took action after BOC training	Would you have taken this action if you had not attended BOC training?			
		Yes	Maybe	No	Don't Know
Water pump optimization changes	n=10	20%	0%	70%	10%
Cooling tower optimization	n=12	33%	0%	58%	8%
Boiler/Hot Water/ Steam System Changes	n=20	35%	15%	40%	10%
Chiller / Chilled Water System Changes	n=13	31%	23%	38%	8%
Economizer and Ventilation control changes	n=22	41%	18%	36%	5%
Domestic Hot Water changes	n=25	44%	24%	32%	0%
HVAC Equipment Scheduling or Space Temperature changes	n=29	31%	34%	31%	3%
Fan optimization/ Air Distribution upgrades	n=17	41%	29%	24%	6%
Lighting changes	n=38	47%	37%	16%	0%
Package/ Split-System HVAC Changes	n=13	46%	38%	8%	8%

Site Visit Follow-Up

Within the internet survey, respondents were asked to provide the necessary contact and logistical information to facilitate phone call and/or site visit follow up; most did so. As can be seen in the table below, 22 respondents representing 36 facilities provided site visit contact information. We are currently calling to schedule site visits and collect more measure specific information with all 47 respondents who took action and agreed to a follow-up call.

Table 58. Internet Survey Respondents Agreeing Follow Up

IOU	All Taken Action		Agree to Site visit		Agree to Phone Call	
	Freq	Sites	Freq	Sites	Freq	Sites
PG&E	12	20	7	13	12	20
SCE	17	33	9	15	17	33
SCG	11	15	5	7	10	14
SDG&E	8	12	1	1	8	12

IOU	All Taken Action		Agree to Site visit		Agree to Phone Call	
	Freq	Sites	Freq	Sites	Freq	Sites
Total	48	80	22	36	47	79

Internet Survey and Non-Responder Survey Sample Comparison

Table 59. BOC Participants – Facility and Actions

BOC Attendee Facility Management Status	Internet Survey	Non-Respondents	Total
	(n=90)	(n=96)	(n=186)
Managing a facility & took action	58%	57%	58%
Managing a facility & did not take action	28%*	16%	22%
Not managing a facility now/Did at time	6%	23%*	15%
Not managing a facility now/Did not at time	6%	4%	5%
Managing a facility not in CA	1%	0%	1%
Do not recall participating in BOC	2%	0%	1%
Total	**100%**	**100%**	**100%**

*Statistically different when comparing internet survey respondents and non-responders at 90/10 confidence

Table 60. Facility Managers who Took Action by Training Year

BOC Training Year	Internet Survey Participants	Non-Respondents	Total
	(n=52)	(n=55)	(n=107)
2010	37%	42%	39%
2011	33%	33%	33%
2012	31%	25%	28%
Total	**100%**	**100%**	**100%**

Table 61. Market Sector/Type of Business in Facility (Internet Survey and Phone)

Market Sector	Internet Survey	Non-Responders	Total
	n=77	n=70	n=147
Government	19%	33%*	26%
School/University	10%	17%	14%

Market Sector	Internet Survey	Non-Responders	Total
	n=77	n=70	n=147
Office	10%	7%	9%
Hospital/Medical	9%	6%	7%
Hotel/Motel	10%	1%	6%
Industrial	5%	3%	4%
Retail	3%	6%	4%
Laboratory	3%	6%	4%
Mixed Use	1%	7%*	4%
Corrections/Jail	4%*	-	2%
Entertainment Theatre	4%*	-	2%
Residential/Apt Building	1%	3%	2%
Real Estate/Property Management	1%	1%	1%
Waste Water Treatment	1%*	-	1%
Art Museum	1%*	-	1%
College Recreation/Wellness Center	1%*	-	1%
Other	3%	7%	5%
Multiple Sectors Across Facilities	12%*	-	6%
(Refused)	-	3%*	1%
Total	**100%**	**100%**	**100%**

*Statistically different when comparing internet survey respondents and non-responders at 90/10 confidence

Table 62. Number of Facilities Overseen

	Internet Survey	Non-Responders	Total
	77	70	147
One facility	57%*	30%	44%
Multiple facilities	40%	67%*	53%
(Don't know)	3%	3%	3%
Total	**100%**	**100%**	**100%**

*Statistically different when comparing internet survey respondents and non-responders at 90/10 confidence

Table 63. Reasons for BOC Attendance – Facility Managers (multiple response)

Reasons for BOC Attendance	Internet Survey	Non-Responder	Total
	n=77	n=70	n=147
Career development	69%*	46%	58%
To save energy/help create a more efficient facility	28%*	14%	36%
Help facility save money	32%*	4%	19%
Required to by employer	13%	17%	15%
Help create a more comfortable facility	17%	11%	14%
To take advantage of the partial tuition rebate	8%	6%	7%
Other, specify	3%	31%*	16%

*Statistically different when comparing internet survey respondents and non-responders at 90/10 confidence

F. Attribution Questions from the Participant Survey

Below we include the survey questions included in our participant survey that were used to calculate free ridership and the NTGR for each measure category.

FACTOR 1: BOC INFLUENCE SCORE

A5. If you were given 100 points to reflect why you decided to take energy saving actions and you had to divide those **100 points** between **1) the influence of the BOC training program** and **2) all other influencing factors**, how many points would you give to the BOC training program?

[RECORD 0 to 100; 998=Don't Know; 999=Refused]

Action Type	Influence of BOC Program	Influence All Other Factors	Total Points
A1a. <Actions from E1TXT-After>	[Numeric Open End]	[Numeric Open End]	<Sum>
A1b. <Actions from E1TXT-After>	[Numeric Open End]	[Numeric Open End]	<Sum>
A1c. <Actions from E1TXT-After >	[Numeric Open End]	[Numeric Open End]	<Sum>
a1d. <Actions from E1TXT-After >	[Numeric Open End]	[Numeric Open End]	<Sum>

FACTOR 2: PROGRAM LIKELIHOOD SCORE

A1. Please consider the following list of actions that you said you have taken after your participation in the BOC training program. For each of these actions, would you have taken the same action if you had not attended BOC training?

Action Type	Yes	Maybe	No	DK
A1a. <Actions from E1TXT-After>	○	○	○	○
A1b. <Actions from E1TXT-After>	○	○	○	○
A1c. <Actions from E1TXT-After>	○	○	○	○
A1d. <Actions from E1TXT-After>	○	○	○	○

FACTOR 3: PROGRAM TIMING

A2. If you had taken these actions without the training, when do you think it would have happened?

Action Type	At the same time	Within 6 months	6 months to 1 year	In 1 to 2 years	In 2 to 3 years	In 3-4 years	Don't know
A1a. <Actions from E1TXT-After>	○	○	○	○	○	○	○
A1b. <Actions from E1TXT-After>	○	○	○	○	○	○	○
A1c. <Actions from E1TXT-After>	○	○	○	○	○	○	○
a1d. <Actions from E1TXT-After>	○	○	○	○	○	○	○

FACTOR 4: MEASURE QUANTITY INFLUENCE

A2b. If you had taken these actions without the attending the BOC training, would you have taken more, the same, or fewer actions than you did?

Action Type	More	Same Number	Fewer	Don't know
A2a. Domestic Hot Water Changes	○	○	○	○
A2b. Lighting Changes	○	○	○	○

G. 2010-2012 Building Operator Certification Program Evaluation Plan

Phase I Effort

This document presents a plan to evaluate the 2010-2012 Statewide Building Operator Certification (BOC) program, a sub-component of the Workforce Education and Training Program operated by four investor-owned utilities (IOUs): Pacific Gas and Electric (PG&E), Southern California Edison (SCE), Southern California Gas (SoCalGas), and San Diego Gas and Electric (SDG&E).

As part of this effort, Opinion Dynamics explored potential methods that could be used to: quantify energy and demand impacts, develop the best method and sampling plan, create initial data collection tools and protocols, and gather the necessary data to support sampling for the impact evaluation effort.

The evaluation team conducted the following tasks to support the development of the evaluation plan:

- **Task 1a. Analyze findings from past BOC research efforts:** The evaluation team reviewed eight impact evaluation reports to assess historical approaches to evaluating BOC impacts. We reviewed the information available from the California PY2006-2008 and PY2010-2012 BOC process evaluations and other previous BOC impact evaluations across the country to help inform the impact evaluation method and sampling plan.
- **Task 1b. Conduct interviews with BOC staff:** The evaluation team conducted five interviews (four with IOU contract administrator staff, and one interview with the Northwest Energy Efficiency Council (NEEC) staff). The interviews explored what information is available from participants as part of the course implementation that might help inform the impact evaluation.
- **Task 1c. Observe BOC training courses:** The evaluation team observed three BOC courses in winter 2012. This allowed us to gain further understanding of what students do and learn in the courses that are relevant to specific actions that can save energy at their facilities.
- **Task 1d. Review tracking databases and course materials/assignments for 2010-2012:** The evaluation team reviewed program tracking databases and course materials, where available, to develop a sampling approach and an understanding of program participation. This review was limited to understanding what information is available for the impact assessment. We will conduct an actual analysis of this information during the impact assessment in Phase 2.
- **Task 1e. Analyze data and develop Phase 2 Evaluation Plan:** The evaluation team developed the following plan that includes a description and rationale for the methodological approach, a description of the recommended sample frame, a description of the proposed methodology for data collection, and bulleted information that should be collected.

In this document, we introduce the Building Operation Certification Training Impact Evaluation that was developed as a result of Phase 1, our scoping effort and evaluation plan. Phase 2 includes the execution of the impact study.

Description of the 2010-2012 Building Operator Certification Program

The Building Operator Certification (BOC) program is a nationally recognized energy efficiency training and certification program founded on the principle that trained and motivated operators can significantly reduce energy consumption. The BOC program, funded by the California Investor Owned Utilities (IOUs) and administered by the Northwest Energy Efficiency Council (NEEC), provides in-depth and hands-on experience to professionals in the building operations and maintenance (O&M) field.

The NEEC, extending efforts initiated by the Washington State Energy Office and the Idaho Building Operators Association, developed the Building Operator Certification program for the Northwest Energy Efficiency Alliance (NEEA) in 1997. The California utilities contract directly with NEEC for administration of the program as a statewide, coordinated initiative in California. The contracts specify the number of courses offered annually and the number of participants registering for training.

BOC combines classroom training, exams, and in-facility project assignments to train and certify building engineers and O&M technicians in the practice of energy-efficient building operations and management. The program provides two levels of training and certification, both of which are designed to improve job skills and lead to improved comfort and energy efficiency at the participant's facility or facilities. The Level I course series focuses on expanding knowledge of building systems equipment and best practices for their efficient operation, while Level II students gain experience in preventative equipment maintenance and targeted training.[21]

The targeted program participants are medium and large commercial end-users who seek certification and who value the importance of efficient building technologies, particularly building engineers and O&M technicians. IOU program funding does not cover 100% of the cost of certification; the balance of the required funding ($1,395 for California residents, $1,595 for non-residents) is contributed by the participant's employer, with a discounted fee offered for each additional employee ($995 or $1,395 for residents or non-residents, respectively) who attends beyond the first employee.

To remain certified, a building operator must accumulate five re-certification hours per year for Level I, and 10 hours per year for Level II. Building operators may obtain these hours by providing NEEC with documentation of completion of qualified activities, including extended learning courses that NEEC has approved as qualifying for this requirement; technical webinars provided on the BOC website; or completion of special projects to improve facility operation, maintenance, and/or energy efficiency.

In 2011 and 2012, the BOC program initiated a Level 1 BOC workforce development pilot program in Oakland, California, in cooperation with PG&E's Pacific Energy Center (PEC). This effort is modeled after a previous pilot program in Seattle, which resulted in a 40% successful employment rate within two months of program completion.

To allow unemployed students to participate in required hands-on homework assignments, PG&E and BOC worked to allow students to use facilities of two local commercial building owners for this purpose. The energy saving impacts of these tasks may be limited, since the students were unfamiliar with the facilities in which they performed these homework tasks, and would likely later be employed in facilities with different needs. A continuation of this program is not planned within PG&E territory for

[21] This description is according to the BOC website http://www.theboc.info/w-value-benefits.html.

2013, though SDG&E is working with NEEC to implement a similar program in their territory. We have accounted for this pilot effort in our sample frame.

Curriculum and Courses Offered

BOC training consists of three components: Level I certification, Level II certification, and continuing education. Level 1 is a series of classroom courses that provides an overview of critical building systems. BOC Level I training consists of seven courses and covers topics related to energy transfer, air movement, heating systems and maintenance, motors, cooling, ventilation and control systems, lighting, electrical safety, environmental health, and safety and indoor air quality. One course is held per month and each is structured to allow for lecture, work in small groups, building tours, the completion of tests and assignments, and the performance of work at one's own facility.

Core curriculum courses must be completed to earn certification. In each region, the program manager may choose one of a suite of supplemental courses to add to that program year based on the needs of the region. This allows flexibility across the many geographical areas where BOC is offered.

Level II is a subsequent series of classroom courses that emphasizes preventative maintenance and more targeted training. To remain certified, a building operator must accumulate re-certification hours. Five hours per year are required for Level I, and ten hours per year for Level II. Various national and regional organizations offer continuing education courses that are applicable to annual BOC certification renewal. As part of the continuing education, BOC provides both live and recorded technical webinars that count towards continuing education credits.

The certification and renewal processes are all managed by NEEC on behalf of the IOUs. The requirement for continued education provides the BOC program with an opportunity to direct students to course offerings at the Energy Centers, which count towards continuing education hour requirements.[22]

Table 1 lists the curriculum for BOC.

Table 64. Level I and II BOC Curriculum

Course Name
Level I
BOC 101: Building Systems Overview
BOC 102: Energy Conservation Techniques
BOC 103: HVAC Systems and Controls
BOC 104: Efficient Lighting Fundamentals*
BOC 105: O&M Practices for Sustainable Buildings
BOC 106: Indoor Environmental Quality
BOC 107: Facility Electrical Systems
Level II
BOC 201: Preventative Maintenance and Troubleshooting Principles

[22] Interviews with BOC program staff, January 2009.

Course Name
BOC 202: Advanced Electrical Systems Diagnostics *
BOC 203: HVAC Systems Troubleshooting & Maintenance *
BOC 204: HVAC Controls & Optimization
Level II : Supplemental Courses (2 offered per course series)
BOC 210: Advanced Indoor Air Quality
BOC 211: Motors in Facilities
BOC 212: Water Efficiency for Building Operators
BOC 213: Mastering the Fundamentals of Electric Control Circuits
BOC 214: Introduction to Building Commissioning
BOC 215: Electric Motor Management
BOC 216: Enhanced Automation and Demand Reduction
BOC 217: Environmental Health and Safety Regulations
*Indicates courses observed through Phase I scoping effort.

BOC courses continually change over time based on feedback from instructors and IOUs, but 2012 saw a more significant change. The bulk of the new content are two core classes entitled *"BOC 1004 – HVAC Controls Fundamentals"* and "*BOC 1006 - Common Opportunities for Low-Cost Operational Improvement*." In addition, the course "*Facility Electrical Systems*" was removed from the core class lists and is now supplemental. In 2012, the new curriculum was implemented in San Ramon, Ontario, and Long Beach, California. The new courses will be offered in 2013 to all participants who began their certification program in the fall of 2012. These changes will not affect our methodology. Table 2 lists this revised curriculum.

Table 65: Level I Revised BOC Curriculum

Course Name
Level I
BOC 1001 : Energy Efficient Operation of Building HVAC Systems
BOC 1002 : Measuring and Benchmarking Energy Performance
BOC 1003 : Efficient Lighting Fundamentals
BOC 1004 : HVAC Controls Fundamentals
BOC 1005 : Indoor Environmental Quality
BOC 1006 : Common Opportunities for Low-Cost Operational Improvement
Level I : Supplemental (1 offered per course series)
BOC 1007 : Facility Electrical Systems
BOC 1008 : Operation & Maintenance Practices for Sustainable Buildings
BOC 1009 : Building Scoping for Operational Improvement
BOC 1010 : EE Ventilation Strategies and High Performance Heating and Cooling Equipment
BOC 1011 : EEE Ventilation Strategies and Energy Savings through Energy Recovery
BOC 1012 : High Performance HVAC and Energy Savings through Energy Recovery

We observed three BOC courses (see Appendix A for more detail) and found that assignments and examinations are key factors in encouraging student engagement and active participation during the course sessions. Instructors also offered many concrete examples and encouraged the class to discuss specific instances in which they could take action in their own facilities.

In addition to attending classes and passing all tests, students must complete a series of facility specific projects.[23] Level I projects include five activities, developing a floor plan of the HVAC system components, an energy performance score for the building using ENERGY STAR® portfolio manager, a utility incentive calculation for a lighting project, a review of HVAC operations and maintenance procedures, and a lighting survey. For Level II students, projects require them to describe a power quality upgrade plan for their facility (or a part of it), compare original HVAC design and operating conditions to current conditions at the facility, and create an AC controls diagram, as well as a maintenance checklist for the facility fan system. Section 0 discusses the number of students in detail.

Potential Energy and Demand Savings

NEEC has compiled a list of 108 likely energy saving actions that could be taken as a result of BOC courses (Appendix C). These actions cover the course as offered from 2010 through 2012. While some locations are beginning to offer the new curriculum in 2012, the new individual courses that has been added (BOC 1006 – Common Opportunities for Low-Cost Operational Improvement) will not be provided until 2013.

Past BOC program impact reviews have generally found that BOC students feel that they can effectively reduce energy use because of the training that they have received. In addition, BOC can represent significant savings as compared to other types of programs. These savings are sometimes claimed in regulatory filings (note that we provide savings ranges below).[24]

The following is a list of key relevant impact and process findings from various reports. None of these findings are specific to California, but apply to the BOC program overall.

- Past BOC program participants have been found to have responsibility for a wide variety of systems and equipment.
- The most common actions taken are HVAC controls, though this can differ significantly by industry.[25]
- Prior energy savings associated with the program(s) are primarily derived from equipment installations performed by certified building operators post-training.[26]
- Changes in operations and maintenance (O&M) practices due to the program vary depending on the type of O&M practice considered.[27]

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[23] NEEC does not currently collect data from these class projects, but we propose that they do so for future impact and process efforts. See Appendix 0.

[24] Southern California Edison PY 2006–08 ETO Process Evaluation. http://www.calmac.org/publications/SCE_ETO_06-08_ProcessEval_StudyNum_SCE0285_finalV2a.pdf

[25] McLain ID Consulting & KVDR Inc., March 2010.

[26] Navigant Consulting, Inc., July 2012. Navigant Consulting, Inc., March 2010. Opinion Dynamics Corporation. September 2009. Summit Blue and Opinion Dynamics Corporation. September 2008. RLW Analytics. June 2005.

[27] McLain ID Consulting & KVDR Inc., March 2010.

- Most students' facilities initiate energy efficiency (EE) projects after BOC training, but less than half indicate that the projects were influenced by BOC.[6]
- Fewer Level II students reported BOC training having an influence on their facility's EE projects than did Level I students (27% compared to 40%).[4]

The evaluation team reviewed a series of evaluation reports to determine appropriate methodological approaches to estimating savings (see Chapter 0) as well as to get a sense for the range of savings available through the program. Table 66 summarizes energy savings estimates for all of the programs in the reviewed evaluation reports (see Appendix 0 for bibliography of reports). Among BOC programs, kWh savings range from 0.02 kWh to 0.72 kWh per square foot. For those BOC programs that calculated it, gas savings ranged from less than 0.01 to 0.02 therms per square foot.

Table 66. Summary of BOC Programs Reviewed

Program Name and Sponsor	Quantified Savings	Claimed Savings	kWh Savings	Therm Savings
Minnesota Midwest Energy Efficiency Alliance (MEEA)	Y	Y	0.72 kWh/sq. ft.	0.02 therms/sq. ft.
Northwest Energy Efficiency Alliance (NEEA) [a]	Y	Y	0.42 kWh/sq. ft.	0.01 therms/sq. ft.
Northeast Energy Efficiency Partnerships (NEEP)	Y	Y[b]	0.18 kWh/sq. ft. per participant	<0.00 therms/ sq. ft. per participant
Kansas City Power & Light (KCP&L)	Y	Y	0.02 kWh/sq.ft. per participant	0.52 therms/sq.ft. per participant
CA Statewide BOC	N	N	--	--

[a] The program serves Washington, Oregon, Idaho, and Montana.

[b] While this report does not specify if the savings are claimed or not, subsequent conversations with NEEC have confirmed that Efficiency Maine Trust, National Grid and Cape Light Compact claim savings from BOC.

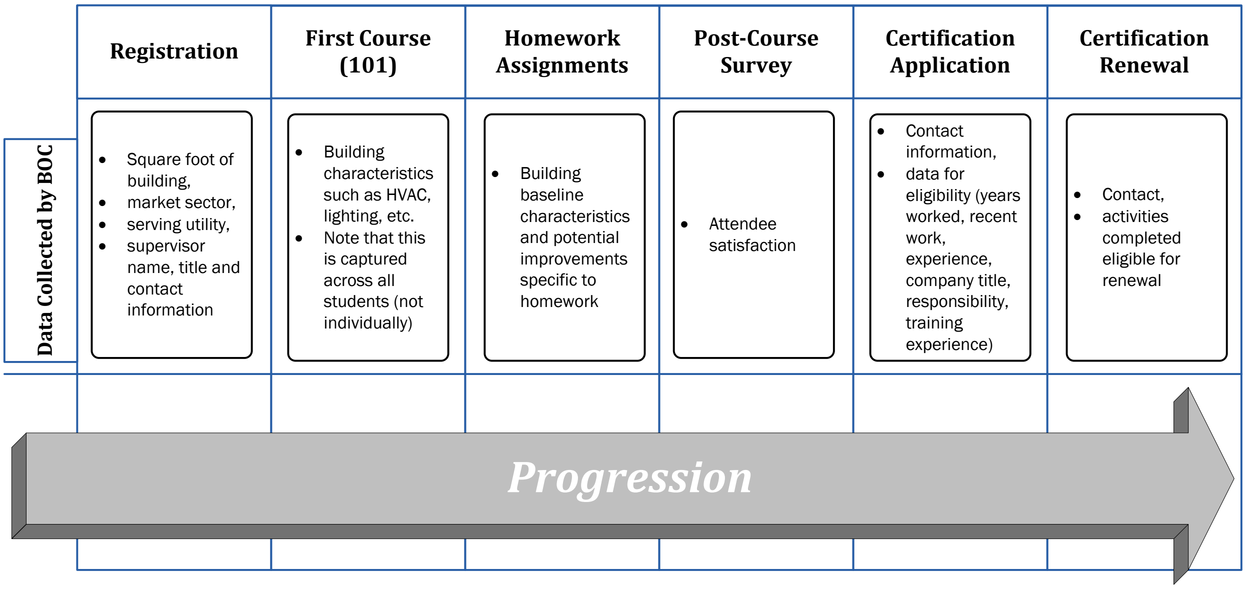
Information was not available on the drivers in the difference in savings, although we expect that building type, size and other characteristics would be potential drivers.

Available Data

The IOUs and NEEC currently collect a significant amount of data from participants, but additional data could be collected to facilitate more accurate impact calculations.

As can be seen in Figure 1, BOC participants provide NEEC and the IOUs with information regarding themselves and their facilities that could serve as inputs to current and future evaluation activities. We have identified six customer touch-points when data are collected by NEEC from BOC participants. These touch-points include registration for the program, first course taken, homework assignments, post-course survey, certification application, and renewal.

Figure 7: Current Data Collection Efforts



As can be seen, each touch-point already collects impact relevant data, such as market sector, square footage of facility, building characteristics, baselines for various building systems, company name, employee name, employee title, and contact information. As part of the BOC continuing certification, participants may verify additional energy saving actions that they have taken due to the course instead of attending BOC-approved continuing education courses.

Notably, most of this information is either not used for impact purposes, or not collected in a manner to support impact evaluations. For example, during the first course, attendees are asked to fill in baseline equipment systems for their facilities via a paper-based survey. These surveys are collected by instructors, summed in aggregate, and sent to NEEC for their records. Additionally, homework assignments require attendees to assess their energy baseline or take energy efficient actions in their facilities, and document the work that was conducted. However, homework assignments are collected, graded, and returned to the attendee. Discussions with NEEC indicate that instructors or IOU staff could make copies of these two items at an individual level and conserve these as inputs into future impact evaluations.

The evaluation team developed a set of proposed data collection items for the IOUs and NEEC to offer to future program participants (Appendix 0). These were developed based upon conversations with IOU contract administrators, NEEC program staff, and informal conversations with course instructors during observations of courses. This information can help to inform impact evaluation efforts for the 2013-2014 program cycle.

2010-2012 BOC Program Participation

This section presents our findings on program participation and the reach of the BOC courses.

Attendee Profile

As part of the evaluation that Opinion Dynamics conducted of the 2006-2008 California Workforce Education and Training program[28], we found that a majority of BOC participants (88%) conducted or managed O&M activities at their facility.[29] In addition, the majority of participants had responsibility for a wide variety of systems and equipment at their facilities, the most common being HVAC controls. Surveyed BOC participants also had responsibility for controlling or reducing energy use (81%), maintaining indoor air quality (75%), and monitoring their facility's energy use (64%).

The previous evaluation also found that participants had an average of just over four years of in-the-field experience at a variety of facility types. Most served in government (31%), commercial (28%), or institutional (28%) buildings, with the remainder primarily in industrial facilities (10%). On average, participant facilities included four buildings and covered 5,677,405 square feet.

In November-December of 2012, the Opinion Dynamics team observed three BOC courses. These courses include BOC 202-Advanced Electrical Systems Diagnostics, BOC 203-HVAC Troubleshooting & Maintenance, and BOC 1003-Efficient Lighting Fundamentals. The participant profile within these courses varied, but had enough similarities to suggest an overall impression of BOC attendees.

Almost all attendees worked in facility management, although few could be described as being in the position of "decision maker." While most participants are not in a position to make budget or policy decisions, a number of them said that they were tasked with bringing lessons from the course back to their colleagues and supervisors. While rare, someone in a management position was in attendance in two of the three courses. This pattern of attendance is consistent with what was reported by the various BOC program managers that we interviewed.

All attendees that we spoke with reported belonging to an organization that owned their facility, rather than rented or leased.

In many cases, multiple representatives from the same facility attended the course together. The areas of responsibility of each participant vary widely, and sometimes overlap with the responsibilities of their colleagues. We will review these databases in Phase 2 to identify this overlap (see Section 0). For example, two attendees may be collectively responsible for the same set of maintenance tasks for the same set of buildings.

The industries represented varied, but for all three courses observed, the majority of attendees worked at a public college campus. We hypothesize that this qualitative observation was due to the fact that public colleges have both an interest in energy efficiency to cut costs, as well as adequate, accessible, and geographically distributed spaces that they can offer as BOC class locations. Offering to host BOC classes also allows their staff to easily access class sites. For example: two-thirds of the students who attended the BOC 202 course that was held at Skyline College were employed as facilities staff of Skyline College. Other industries that were observed to attend include county or city government, health care, petrochemical, and private industry. This closely follows the market sectors of 2010-2012 participants as recorded by NEEC during program registration (Table 67).

[28] Opinion Dynamics Corporation. December 2012.

[29] A small percentage of BOC participants (12%) are not directly involved in O&M and among these individuals, all enrolled in the Level 1 program. The top reasons given for participation were knowledge acquisition (35%), applicability of the training to their current position (23%), and that enrollment was requested or required by their management (15%).

Table 67. PY2010-2012 BOC Participants by Market Sector (Level I and II)

Market Sector	Level I	Level II	Level I & II	Total
Municipality (city or state or utility)	30%	38%	34%	33%
Manufacturing	12%	3%	3%	9%
Facility Services	6%	11%	17%	9%
Other	5%	16%	9%	8%
Healthcare	6%	3%	11%	7%
Hospitality	4%	10%	11%	7%
Government (not city/state specific)	9%	4%	2%	7%
Military	4%	4%	8%	5%
K-12 School	7%	2%	0%	5%
Government	6%	1%	1%	4%
Property Management	4%	1%	0%	3%
College	3%	3%	0%	2%
Retail	2%	5%	2%	2%
(None given)	2%	0%	0%	1%

Note: Table 67 is based on an n of 821 as provided by NEEC's CVent database. While slightly different than the number of participants provided by the IOUs, these percentages should be representative and are provided here to give context.

BOC participants differ slightly within each program level. Students in Level II have usually been certified in Level I. If this is not the case, a student must show that they have significant professional energy management experience.

Program Participation

The following information on program participation represents the California BOC Level I and Level II participants from January 2010 through June 2012. Notably, some participants are currently enrolled in Level I or Level II courses in the fall / winter 2012, and their enrollment in the series will continue through Q1 2013. These participants are not included in our participation overview.[30]

[30] We recommend that these participants be included in the next program cycle evaluation.

Table 68. PY2010-2012 BOC Participants across State and IOUs

IOU	Level I	Level II	Total Unique Parts	Total Parts
PG&E	173	51	216	225
SCE	321	96	399	418
SCG	50	19	68	69
SDG&E	97	26	123	123
Total*	**641**	**192**	**794**	**835**

* Does not represent a total of each IOU, as there are customers who have taken classes across IOUs.

Table 69. Unique PY2010-2012 BOC Participants Over Time

IOU	2010 (unique)	2011 (unique)	2012 (unique)	Total (unique)	Total Participants
PG&E	79	91	54	216	225
SCE	103	164	147	399	418
SCG	27	19	23	68	69
SDG&E	45	50	28	123	123
Total*	**252**	**317**	**251**	**794**	**835**

* Does not represent a total of each IOU, as there are customers who have taken classes across IOUs.

Table 70. Percent of PY2010-2012 BOC Participants with Contact Information (Unique information)

IOU	*Percent with Phone #*	*Percent with Email Address*
PG&E	*175 (81%)*	*206 (95%)*
SCE	*301 (75%)*	*383 (96%)*
SCG	*54 (79%)*	*65 (96%)*
SDG&E	*94 (76%)*	*112 (91%)*
Total*	***610 (77%)***	***753 (95%)***

* Does not represent a total of each IOU as there are customers who have taken classes across IOUs.

Table 71. PY2010-2012 BOC Participants by Program Year

Year	Level I	Level II	Grand Total
2010	143	113	256
2011	276	49	325
2012	223	31	254
Total	**642**	**193**	**835**

Table 72. Self-Reported Square Footage of PY2010-2012 BOC Participants

Square Footage	Level I	Level II	Level I & II	Total
> 1 million	17%	26%	18%	19%
751- 1 Million	5%	8%	8%	6%
451-750K	5%	8%	9%	7%
351-450K	4%	3%	2%	4%
251-350K	6%	7%	11%	7%
151-250K	10%	5%	9%	9%
101-150K	5%	3%	7%	5%
76-100K	9%	1%	7%	7%
51-75K	6%	2%	8%	5%
25-50K	3%	5%	1%	3%
<25K	5%	3%	0%	4%
Unknown	25%	28%	19%	25%

Note: Table 9 is based on an n of 821 as provided by NEEC's CVent database. While slightly different than the data provided by the IOUs, these percentages should be representative and are provided here to give context.

Table 73. BOC Participants by Unique Company and Address by IOU

IOU	Unique Companies	Unique Addresses
Overall*	353	426
PG&E	102	123
SCE	173	217
SCG	37	43
SDG&E	73	62

*Note: Companies and addresses are represented more than once across IOUs, and so the IOU values collectively total to greater than the overall number of unique companies and addresses.

Table 74. BOC Participants by Unique Company and Address Over Time

Year	Unique Companies	Unique Addresses
Overall*	353	426
2010	136	161
2011	129	150
2012	138	165

*Note: Companies and addresses are represented more than once across years, and so the year values collectively total to greater than the overall number of unique companies and addresses.

Methodological Approaches to Assessing BOC Impacts

The evaluation team conducted a review of historical approaches to evaluating the BOC program for impacts. In addition, we assessed the most feasible approach to evaluating BOC for the 2010-2012 program cycle, given budget limitations and timing constraints (report due in June 2013). We begin by discussing our findings from a historical review of evaluation approaches, followed by the rationale for our proposed evaluation approach.

The evaluation team reviewed eight reports related to BOC impact evaluations to identify methodologies for estimating gross and net savings impacts for these courses (see Appendix 0 for bibliography of reports).[31]

Our review focused on the following criteria:

1) Analytical methods to assess gross savings, including energy action baselines
2) Cross-program attribution (e.g., "double-counting")
3) Analytical methods to assess net savings impacts
4) Persistence of savings

We describe our findings below.

Gross Savings

Gross savings are any savings that occur within a relevant period of time following program participation. As noted in Chapter 2.2, among BOC programs, kWh savings range from 0.04 kWh to 0.72 kWh per square foot. For those BOC programs that calculated gas savings, savings ranged from less than 0.01 to 0.02 therms per square foot.

All of the reports examined used a mix of participant self-report and secondary data to conduct an engineering analysis to determine gross energy and demand impacts. This is the process of asking participants detailed questions regarding actions taken after program participation, then using engineering models to estimate savings due to these changes. The methodology used by evaluators to gather this information and assess gross program impact includes:

- **Participant Surveys**: Depending on the level of program participation, the impact evaluation attempted a census or developed a sample. Key metrics for sampling included building type and size.
- **Secondary Data Review**: To support the engineering analysis, impact evaluations drew upon existing data sources such as the Commercial Buildings Energy Consumption Survey (CBECS), the California Commercial End-Use Survey (CEUS), and the Database of Energy Efficiency Resources (DEER) to determine savings for specific measures, as well as to gather information on baseline load intensities among other uses.

Among BOC programs, the estimation of energy and demand impacts requires detailed information about the energy and demand actions that participants took, the locations in which those changes were made, and the equipment or behavior that was replaced. In addition, evaluators need to collect information regarding the size of buildings that building operators are responsible for, as well as the building type, and heating and cooling fuels.

[31] Note that we also reviewed process evaluation reports for BOC and other impact evaluation reports for similar education based programs.

It is also critical to understand the baseline (or existing behavior) of program participants (whether building operators or other audiences), as well as changes in those behaviors since program participation. Among all of the impact evaluations examined, baseline usage was calculated through pre-calculated engineering estimates and self-reports from participants. Three studies calculated the baseline by using a pre-calculated baseline estimate, such as the 2009 Northwest Commercial Building Stock Assessment. These baselines are modeled from a variety of technical parameters, such as building size, equipment type, and year of construction, as well as engineering equations such as those offered by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). These baseline estimates can be used as-is[32], or partially customized using information from participant surveys[33]. Four of the reviewed studies took this approach.

Notably, prior studies did not draw on baseline information collected within each course. At present, some basic baseline equipment information is collected at an aggregate level, along with anonymous course evaluation forms. More detailed information is also provided by participants as part of the take-home tasks for each course, though currently this data is not recorded after the assignments have been graded by the course instructor. Conversations with NEEC indicate that minor changes to the current procedures may enable this data (or even additional data) to be a rich source of data for the future.

Across all of the reports reviewed, program savings are generally estimated based on changes in practices as well as the installation of energy efficient equipment.

The most common savings metric among the BOC evaluations is savings per square foot.[34] This metric is useful for comparing program results to baseline energy intensities or regional savings potential estimates, which are typically reported as savings per area. Many studies divide this by the number of BOC participants on site to calculate savings per square foot per participant. This provides a normalized savings estimate, accounting for both the size of the participant building and the number of program graduates from the site. This allows for extrapolation of savings to the population, as well as a default value to apply to future program participants. (Note that seven of eight evaluation reports assess net savings, we document these efforts in Section 0.)

Our evaluation will field surveys to all BOC participants, but will also provide aggregate findings by company and/or site address. Based on BOC program design there is an incentive for companies to send more than one employee to a BOC training course (given the reduced cost per additional employee). As a result, the evaluation team will review participant survey results from within the same site address (and/or within the same company) to assess whether actions taken were solely conducted by one participant or across all company participants. From this analysis, we will qualitatively assess whether or not there are any incremental savings at a site level due to multiple BOC participants per company, (i.e. does the number of participants per company influence savings?)

32 Navigant Consulting, Inc. March 2010. Xenergy Inc. March 2001.

33 Summit Blue and Opinion Dynamics Corporation. September 2008. Opinion Dynamics Corporation. September 2009. Opinion Dynamics Corporation. November 2003.

34 Studies have identified savings per square foot related to the square footage that the participant is responsible for.

Discussion of Approach

The historical review of evaluation reports document one approach to estimating gross energy savings: participant survey data that incorporates secondary data to estimate savings via an engineering analysis. We note that there are additional approaches that could be employed to assess BOC program impacts beyond what has been accomplished to date, which include site visits to inform engineering estimates, statistical analysis of customer billing data, and on-site metering. We discuss these additional approaches and their feasibility given the context of this evaluation below.

Factors that must be considered in matching these three approaches to the evaluation include the size of the expected impact, the degree of site-by-site variation in per unit savings, the aggregate size of the measure's impact at the program level, the cost of applying the savings estimation method, the sampling size and associated sampling error (if sampling occurs), and the reliability of the measured data. Table 75 provides a list of 'must-haves' for determining the feasibility of engineering analysis, statistical analysis, or metering.

Table 75. Checklist of Needed Items for Gross Energy Estimations by Approach

Gross Energy Estimations Approach	Checklist of Items Needed
Participant Surveys for Engineering Analysis	• Customer Contact Information
Site Visits to Inform Engineering Analysis	• Site address for site visits
Statistical Analysis of Customer Billing Data	• Account # • Meter at relevant site level • Changes in energy use not associated with BOC • 12 months pre-post billing data
Metering and Trending	• Access to site prior to participation in program • Access to O&M staff who will cull historical trends from EMS for analysis

As can be seen in the table, each approach requires key items that are needed for assessing program energy and demand impacts. If the "must-haves" are not available during a program evaluation effort due to timing constraints or limited access to data, one approach becomes more or less relevant. We discuss each below.

Participant Surveys to Inform Engineering Analysis—Recommended Approach

All impact evaluations conducted to date for BOC use some form of a participant survey to inform an engineering analysis. This approach works towards collecting self-report data through a phone or Internet survey and using inputs from the survey to develop baseline energy use profiles, and subsequent energy savings actions taken.

One of the primary challenges to this approach is the difficulty of collecting sufficient information regarding energy savings actions taken (replacement and changes to O&M behaviors) within the short time frame of a telephone or Internet survey. Compounding respondent burden is the fact that the data collected is self-report and not verified by an engineer on site. An increased level of rigor for collecting participant baseline as well as actions taken is to assess the building systems and actions on site.

One method to reduce respondent burden is to develop baseline practices from existing data. However, after discussions with IOU program management and NEEC staff, it is apparent that pre-participation surveys and program workbooks will not provide sufficient information to develop a baseline of energy savings actions for participants. (Note that we make recommendations for future program cycles to capture this information starting on Page 150.)

Some form of participant surveys will be required in any method used as secondary information and account information are not available.

Site Visits to Inform Engineering Analysis—Recommended Approach

Despite the fact that other impact evaluations have not incorporated site visits into their data collection efforts, the evaluation team believes that site visits can lend additional precision to energy savings estimates, as well as reduce respondent burden from the participant survey.

Calculating impacts for many of the actions that are taught in the BOC courses require detailed knowledge regarding the building systems and characteristics that are not easily collected via an Internet or telephone survey. It may be difficult to collect building equipment characteristics and actions taken (over 108 according to NEEC) through one survey. In addition, BOC attendees may not be prepared to answer some of these questions over the phone, requiring visiting a system or measure to identify equipment specifications and other details.

Site visits are also beneficial as we may not want to solely rely on secondary data, such as current codes, for engineering analysis. In fact, it may be difficult to locate secondary sources that discuss O&M practices and assumptions inherent in estimating energy savings from these actions. As such, site visits mean that we will not rely on secondary data alone, but rather more accurately reflect the usage of actual program participants.

Statistical Analysis of Customer Billing Data—Possible Option for Future

Statistical analysis of customer billing data is an alternative approach to estimating energy savings. The benefit of this approach is that it accounts for interactive effects of multiple actions taken over the course of time.

The feasibility of conducting this type of analysis is reliant upon access to metered billing data, and can only be performed on facilities with limited changes in energy usage outside of program efforts (i.e., occupancy changes, major retrofits, etc.), with sufficient pre- and post-billing data and information as to when actions were taken. The largest hurdle for this approach is accessing customer billing information, as BOC programs typically do not require participants to provide customer account information, and accessing this information can require substantial effort.[35] An additional constraint is identifying whether the customer billing information covers the facility where actions are performed. For example, if a program attendee is responsible only for a certain portion of a customer's facility, savings within that area are may not be detectable when examining billing data for the entire facility as a whole. To achieve enough statistical power to detect small effects, it is necessary to have a large sample size. In addition, it can be challenging to distinguish any observed savings as being a direct result of the program rather than due to other external factors that occur over time.

[35] The evaluation team could attempt to collect account information at time of the interview. In addition, the evaluation team could use site address toward matching with Site IDs which the IOUs now use.

The result of the analysis would provide average annual savings per facility as well as total program savings applied to the entire population (including those that were removed due to insufficient pre-post billing data) of customers.

As such, we consider statistical analysis a viable option for estimating gross energy impacts; however, it is unclear as to whether the data required for this approach is available for the current evaluation effort.

Metering and Trending—Not Recommended for Current Evaluation

A metering approach uses primary data collection through installing loggers at participant sites in advance of their participation in the BOC program. This will allow the greatest level of precision, by monitoring actual energy use as an aggregate across the facility, or preferably in association with each individual measure. Trending is essentially having an O&M staff member collect and provide historical trending data from their EMS system.

For metering, the primary challenge to this approach is that an evaluator will not know what will happen, when it will happen, or which participants may take actions. Metering must be implemented before the participant has been exposed to the program in order to yield an accurate baseline. This creates logistical challenges regarding timing and site access, as well as additional expense due to increased labor hours and the use of metering devices. Given the fact that most evaluations begin upon the conclusion of the program year or program cycle, this approach is not feasible for the evaluation at hand. Further, there may be selection bias in terms of the participants who agree to installation of loggers in their facilities, as those participants may be inherently more inclined towards taking actions, or may be even more inclined with the knowledge that their actions will be measured over time.

Trending presents several challenges as well, given that the onus for data collection is placed on the building operator staff to collect historical energy trending data to provide energy savings changes. Additionally, trending changes occur at a significantly shorter period of time (i.e., one to two weeks) than a typical evaluation period of one to three years and as such is more difficult to measure over time.

As such, we do not recommend this approach as the program participants have already taken action within the program cycle.

Proposed Approach

Our review of the existing evaluation literature demonstrates that self-reported data on behavior change, knowledge gain, and measure installation as a result of program participation forms the foundation of most methodological approaches to quantifying savings.

Based upon our understanding of the historical approaches for estimating gross energy savings, the evaluation team proposes estimating gross energy and demand impacts through conducting participant surveys, with subsequent site visits to determine energy impacts through engineering analysis. The evaluation will provide annual energy and demand savings per participant, per square foot, per site address (and / or company), per IOU, and statewide if sufficient numbers of completes occur.

We propose to estimate annual gross energy and demand impacts through the following data collection efforts:

- **Participant Survey via Internet:** We will field an Internet survey to a census of the participant population. The survey will gather data to identify and collect detailed inputs needed for engineering analysis.

- **Secondary Data Review:** To support the engineering analysis, we may draw upon existing data sources such as those noted above.

- **Site Visits:** To enhance the rigor of our estimates and reduce respondent burden, we will conduct site visits on the population[36] of participant survey respondents to verify actions taken and collect additional data required for selected measures.

We will calculate annual gross energy and demand savings impacts using these three data sources via an engineering analysis.

Cross-Program Attribution

In California, the BOC program design facilitates channeling attendees into California IOU energy efficiency programs. This is also the case for BOC programs offered in other states. Three historical studies did not directly address cross-program attribution, assuming that this was accounted for when considering general program influence.[37] However, this can lead to "double-counting", i.e., tallying gross savings from the BOC program that are already being counted as gross savings from other IOU EE programs, or vice versa.

Of the eight studies we reviewed, two[38] directly asked participants if energy savings actions taken after BOC program participation were incentivized or rebated by other EE programs. Both found that a large percentage of BOC gross program savings were removed when rebates were factored into the analysis. In one case, they were reduced by half[39] and another by two thirds[40], when rebated measures were excluded. In these cases, two different savings values were reported; one with cross-program savings removed and another with these savings shared.[41]

Two other studies accounted for cross-program influence in other ways. One study addressed cross-program influence in the context of a more comprehensive cognitive change index, and so did not ask a separate cross-program question for each measure.[42] The other study reviewed a program that directly reviewed and funded each measure completed, and so cross-program attribution did not apply.[43]

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36 We acknowledge that attrition may occur by conducting site visits from a sample of participant survey respondents. As such, we are building in flexibility to our sampling strategy that may consider sampling directly from the population of participants. We will assess the feasibility of this approach based upon participant survey completes.
37 Navigant Consulting, Inc., July 2012. Opinion Dynamics Corporation, September 2009. Summit Blue and Opinion Dynamics Corporation, September 2008.
38 Minnesota Midwest Energy Efficiency Alliance (MEEA) - Navigant Consulting, Inc., March 2010. RLW Analytics, June 2005.
39 RLW Analytics. June 2005.
40 Navigant Consulting, Inc. March 2010.
41 Minnesota Midwest Energy Efficiency Alliance (MEEA) - Navigant Consulting, Inc., March 2010. RLW Analytics, June 2005.
42 Opinion Dynamics Corporation, November 2003.
43 Xenergy Inc., March 2001.

There is an additional approach that could be employed to assess cross-program attribution, which is a cross-reference of program participation databases with BOC participants. This effort would be more accurate than relying on participant self-report information.

The primary challenge associated with cross-referencing program databases is that it requires access to the IOU C&I customer databases for PY2010-2012, as well as access to customer account information at the correct level to cross-reference with the database (i.e., premise level, customer account level, etc.) We anticipate that many of the BOC program participants will be unable to provide accurate customer account information, and this information is not required to be provided during the registration or participation process for the program.

Proposed Approach

The program is designed to educate BOC attendees about IOU energy efficiency rebates and how they can be applied in their facilities. To assess whether BOC attendees participate in IOU energy efficiency programs, the evaluation team will incorporate a battery of questions into our participant survey to ask if rebates were received, the equipment replaced, and when replacement occurred.

The evaluation team will assess cross-program attribution of program savings through responses to the participant survey. Responses from this survey will be used to identify whether any of the reported energy savings actions also utilized a rebate or incentive from an IOU energy efficiency program. If so, the evaluation team will deduct the estimated energy savings value from the total gross savings for the participant.

Gross BOC Savings = Sum of Energy Savings Actions Estimates – Energy Savings Rebated through IOU EE program

As an addition to our research, the evaluation team will also cross-reference the PY2010-2012 IOU C&I program databases if the databases are available. We would collect account information during site visits with program participants. A similar process would be employed, whereby energy savings rebated through IOU EE programs would be deducted from the gross energy savings estimates.

Program Attribution

Program attribution assesses the energy and demand impacts that are due to the program. There are two methods that have been used to assess BOC net impacts in the past: participant self-report and comparison with a non-participant group baseline. These approaches essentially develop a "counterfactual," i.e., what energy and demand impacts would have occurred without the program.

Participant Self-Report

To assess net program savings, seven of the eight impact studies reviewed calculated an influence score through participant self-report to determine the extent to which each action taken (or each unit of energy saved) can be attributed directly to the program. This influence score is sometimes called a free ridership score, or in one case, a cognitive change index. This score is used to isolate net from gross savings. The simplest example of this process is as follows: If a respondent says "6" when asked to rate the program's influence on a particular energy saving measure on a scale from 1 to 10, then 60% of the savings from that measure would be attributed directly to the BOC program.

We note that developing appropriate questions can be challenging for the BOC program, as standard net-to-gross batteries used for rebate programs do not cover all of the nuances of identifying program influence on changes to actions and behaviors. There are several barriers that exist along the decision-making continuum (e.g., lack of measure/behavior knowledge; lack of inspiration; lack of implementation know how, etc) which the courses may help attendees overcome. Standard self-report NTG batteries are primarily designed for a rebated measure program whose participants are at the end of the decision-making continuum, whose alternatives are mainly the status-quo or the standard efficiency measures/approach, and for whom the program incentive can be especially persuasive to adoption of high efficiency.

In more typical resource acquisition programs, participation is defined as using program support to install a particular measure or take a specific action. When we measure net effects for these type programs, a net-to-gross ratio is applied to gross energy impacts to *screen out* free riders, that is, program participants “who would have implemented the program measure or practice in the absence of the program.”[44] The default assumption is that the participant took the actions as a result of the program (i.e., gross savings) and we ask questions to disprove this assumption.

For non-rebate programs such as information, education, and training, determining net savings can utilize alternative approaches. When we attempt to look at energy savings for informational programs, we are “building up” the savings; as opposed to assuming that participation equates with taking energy saving action. The default assumption for each person touched is that they learned something that would change future energy saving actions. As such, evaluation efforts could provide additional insights through contextualizing the standard concept of net-to-gross (screening out savings) for information, education, and training programs. For example, one report developed survey questions that combine to create a cognitive change index (CCI) that is used as a proxy for net savings analysis.[45]

The CCI determines cognitive change based on three specific concepts:

1) **Was the information presented new?** Program theory indicates that the courses must be responsible for increasing knowledge to be given credit for actions taken. Therefore, if the information was not new or did not move forward existing plans then the course information was not part of the reason why actions were taken.

2) **Was there a cognitive change based on the information?** The course must create a cognitive change before actions taken are considered attributable to the program. Although similar to concept 1 as both are attempting to measure cognitive change, it is different from concept 1 because it is measuring a range of change, not a dichotomous value.

3) **Direct self-report of program influence on actions taken**. The third measure is a direct self-report of influence of program information on actions taken.

[44] California Energy Efficiency Evaluation Protocols: Technical, Methodological and reporting Requirements for Evaluation Professionals. April 2006. TecMarket Works Team, p 226.

[45] In August 2008, the Evaluation Team worked with the CPUC and MECT to arrive at an agreed upon method for calculating net behaviors for all three evaluation efforts led by Opinion Dynamics: the Statewide Marketing & Outreach programs, Statewide Education and Training Program, and the Information and Education Programs. It was agreed that Opinion Dynamics would adjust the questions used in the CCI calculation based on the program differences but use the same approach (i.e., calculate the CCI) for all three of the evaluation efforts.

Non-Participant Self-Report

An alternative approach to assessing net savings is through comparing pre and post energy usage with a comparison group. In this case, the difference in actions taken between the non-participant group and the participant group would result in net energy savings.

Two of the reports[46] reviewed assessed net savings with this approach, with the comparison group being current building operators that had not pursued BOC training from the NEEC marketing list. In one of these reports, non-participants were interviewed both at the beginning and end of the program via a survey effort, allowing for greater precision than a one-time survey as non-participant baseline practices may have been affected by other external factors such as economic impacts, weather, other efficiency program offerings, etc.[47]

Using this approach is effective when the comparison group is equivalent to the participant group. In the case of the reports that employed this approach, participants may exhibit a selection bias from the non-participant group (i.e., the participants chose to take the course or their employers valued the course) which may have an effect on what types of actions are taken in buildings. In addition, a comparison group should be equivalent in terms of the building characteristics and system types within the building. Comparing actions that are taken for certain measures with a group of non-participants who are unable to take those actions due to the type of facilities that they operate is also infeasible. When using a comparison group, it is critical to be able to match the comparison group to the participant group so that they are equivalent, and in many cases would require a large sample size of non-participants to match the scale of actions that could be taken within a facility. In addition, as discussed earlier, participant characteristics change based on location of the course.

In addition to assessing net actions from a baseline of comparison group actions, both of these studies also employed a participant self-report net savings analysis. We believe that it is not appropriate methodologically to combine the two approaches, participant self-report and comparison group baseline development, as this will essentially "double-ding" the program. One report applies a content and frequency factor to assess changes in practices as a result of BOC training, as well as applies a participant self-report influence score, and further compares these savings to a non-participant baseline. While we agree that a comparison group baseline can be deducted from a participant group self-report to assess net savings, applying both approaches is an overly conservative estimate of savings. We acknowledge, however, that there is valuable information gained from non-participant efforts.

Proposed Approach

The evaluation team proposes a self-report attribution battery incorporated within the participant survey to assess the level of influence the BOC course had for each energy savings action taken during the course period. We acknowledge that additional research is needed to understand the best methods of identifying attribution for training programs. Note that there is a proposed study for attribution of education programs in the WE&T evaluation plan.

We propose to employ a direct attribution question in conjunction with any standard protocols used in California for establishing attribution. We will also include some questions to help participants consider all of the ways that the courses could have influenced them prior to asking the direct attribution

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[46] Navigant Consulting, Inc. July 2012. Navigant Consulting, Inc. August 2012

[47] Navigant Consulting, Inc."Estimating Savings from Building Operator Certification Training". 2012 ACEEE Summer Study on Energy Efficiency in Buildings. August 2012

question (e.g. learned about new technologies, how to assess their building and find energy solutions, how to calculate the ROI for upper management approval, and/or how to implement projects, etc.) The evaluation team will collaboratively develop a set of questions and algorithm to measure program attribution consistent with previous evaluation efforts, as well as the California protocols. Note that the CCI algorithm will not be employed in the analysis but some of the CCI questions may be used to help prime participants before the direct attribution question.

Persistence of Savings

While the majority of energy savings impacts from BOC appear to be derived from equipment replacement, O&M activities could save energy over a long period of time. Two of the eight studies reviewed took energy savings persistence into account. One impact evaluation study[48] calculated persistence of O&M practices by interviewing participants one year after BOC participation, and then again four years after participation in the program. Persistence was found to be over 100%, resulting in significant kWh and MMBtu savings. The study found that the assumption that the duration of program influence was estimated to be five years was reasonable.

Another study[49] assumed that O&M practices would persist as long as the BOC student remained at their position, and so used U.S. Department of Labor Bureau of Labor data to determine that the Effective Useful Life (EUL) of BOC O&M training practices would be five years. This was not, however, used to calculate gross or net savings, but rather to calculate the long-term cost-benefit analysis for the program.

Proposed Approach

For this evaluation, the evaluation team will provide annual energy estimates per participant. The evaluation team will provide an assessment of the persistence of gross energy and demand savings beyond the year of participation for replaced equipment by using EUL. For O&M practices, the literature suggests a duration of five years for each action taken. According to data provided by NEEC, the average length of time between the most recent certification[50] and renewal is 4 years, with a median of 3 years (range of 2 to 14 years). It is possible for BOC participants to have their certification lapse and then get renewed for more than one year (however this requires direct contact with BOC staff as well as cumulative qualified education hours). We propose to use a duration of four years for a conservative estimate of O&M persistence. We will provide the replaced equipment lifetime savings separate from the annual participant savings estimates.

Proposed Statement of Work for Phase 2

This chapter outlines the proposed tasks for Phase 2 of the Building Operator Certification Training Impact Evaluation, a sub-component of the Workforce Education and Training Program. Phase 1 was a scoping effort and evaluation plan, while Phase 2 includes the execution of the impact study.

As part of the Phase 1 effort, Opinion Dynamics explored the potential methods that could be used to quantify energy savings (see Chapter 0), developed the method and sampling plan, began drafting initial data collection tools and protocols, and gathered data to support sampling (see Appendix B) within Phase 2 of the impact evaluation effort. Phase 2 is anticipated to begin in February 2013.

48 RLW Analytics, June 2005.
49 Summit Blue and Opinion Dynamics Corporation, September 2008.
50 Re-certification requires 5 hours of qualified instruction.

The evaluation team also considered a series of additional optional efforts to estimate BOC program savings. Due to budget constraints, these efforts are infeasible for this program cycle, but we placed the write-up of these optional efforts in Appendix 0 for review for future program cycle evaluations.

Research Objectives

The specific research questions for the Phase 2 effort include:

- What are the baseline O&M practices that program participants employ in their facilities and the energy efficient equipment in place prior to participation in the program?
- What are the gross annual energy (kWh and therm) and peak demand (kW) savings from participating facilities?
  - What are the gross energy savings impacts per participant? Per square foot? Per series? Per site address (or company)?
  - Which actions are most frequently taken by BOC participants? Which of these actions result in the highest energy savings?
- What amount of channeling occurs from the BOC program to the IOU's energy efficiency rebate programs, and how much energy savings is attributable to the BOC series (i.e., what is double-counted)?
- What are the net energy savings impacts due to participation in the program?
  - To what degree has the program influenced participants' decisions to install energy efficient equipment or take O&M actions?
- What is the persistence of energy savings actions over time?

Evaluation Tasks

Below we outline the various evaluation tasks. The proposed evaluation approach was developed based upon a review of historical approaches used to estimate gross and net energy and demand impacts for BOC programs, as well as timing and budget constraints for this evaluation. Chapter 0 provides a discussion of approaches employed, as well as the rationale for the selection of the approach outlined below.

Evaluation Kick-Off and Finalization of Evaluation Plan

Opinion Dynamics will finalize the evaluation plan after receiving comments from Itron, the CPUC, and the CPUC's consultants. We will host a kick-off meeting in early February (i.e. proposed meeting planned for February 21st) to gain buy-in to the approach.

The finalization of the evaluation plan will occur following this meeting.

Deliverable: Final Phase 2 Evaluation Plan *Deliverable Date: February 2013*

Program Database Review

Opinion Dynamics has reviewed the IOUs program databases to assess the best sampling approach for the data collection efforts proposed. However, further efforts, particularly a review of NEEC's data, e.g. multiple participants per course, will occur as we launch Phase 2. This effort will assist in finalizing our sample frame for the participant survey and site visit sampling.

Database review will occur in January – February 2013.

Deliverable: None *Deliverable Date: February 2013*

Participant Survey

Opinion Dynamics will conduct an Internet survey with a census of 2010-2012 California program participants (N=~821). Note that we will exclude the following participants from our census:

- PG&E attendees that were sponsored through grant funding for workforce development. These 12-15 attendees were unemployed and conducted energy savings actions on hosting facilities. Because these attendees are distinct from other participants, we have chosen to exclude these from our sample. Note that these attendees are currently included in our participant count as we are waiting to confirm which of these attendees were part of the workforce development program. (The CPUC may wish to conduct in-depth interviews as an optional add-on task but this is not currently included.)

- Attendees whose series will continue through Q1 2013. Some IOUs are still in the process of offering courses on Level I and Level II series from Q4 2012 through Q1 2013. These attendees will be excluded from the sample frame as they have not participated in the full series. Note that these attendees are not included in the current participant count.

Because the participant survey will be conducted on a census of the participants (excluding the two groups noted above), we will not employ a sample design or create a sample frame. However, the evaluation team may aggregate participant level survey data to company or site address level after the survey is conducted. The data collection effort will be generalizable to the California 2010-2012 BOC participant population. Depending upon response rates, we may be able to provide findings by IOU, by facility size, by market sector, and by Level I or Level II series attendees. We estimate a 20% response rate from a total participant population but will work to get as many completes as possible.[51]

To minimize non-response and self-selection bias, we will include the entire sample frame and provide follow up email reminders. We will also attempt to limit self-selection bias by telephoning non-responding participants where telephone contact information is available. To minimize measurement error, we will carefully design and review all surveys to assure that our instruments are both reliable and valid. We will review questions to assure that double-barrel questions (i.e., questions that ask about two subjects, but with only one response) and “loaded” questions (i.e., questions that are slanted one way or the other) are not asked. At times, scales will be constructed so that multiple items (which increase reliability) are used to assess an underlying construct. Where multiple items are provided for choice, their order will be randomly changed. The overall logical flow of the questions will be checked so as not to confuse respondents and thereby decrease reliability. Key members of the evaluation team as well as Itron, the CPUC, and the CPUC’s consultants will review all drafts of the various survey instruments.

[51] The participant population excludes our estimate for workforce development attendees.

The participant survey will collect the following information to inform impact evaluation efforts (note that in Appendix 0 we identify potential data collection sources by energy savings actions, participant survey or on-sites):

- **Energy Savings Actions Taken**
    - O&M actions taken in 2010-2012, dates when actions first initiated, frequency and duration of actions taken, baseline of previous actions taken, if any (these will be drawn from the 108 actions provided by NEEC listed in Appendix 0)
    - Energy efficient equipment replacement actions taken, dates when new EE equipment was installed, information regarding replaced equipment
- **Building Characteristics**
    - Confirm air conditioned square footage, and overall square footage of facility that participant is directly responsible for, other building characteristics (age, number of buildings, market sector, heating type, fuel type, etc.). Note that NEEC captures this data from participants, but suggested that the information may not be exhaustive for respondents and may not be accurate
- **Program Influence Information**
    - Number of course attendees operating at same facility
    - Self-report battery of questions assessing program influence in energy savings actions taken
- **Cross-Program Attribution**
    - Rebates or incentives used for any replaced equipment noted in 2010-2012

The data collected will inform gross impacts estimates, as findings will serve as inputs into engineering algorithms. In addition, responses to the program influence survey battery will also provide inputs into net energy savings estimates. Additionally, the evaluation team will incorporate a question into the instrument to describe cross-program participation with other WE&T courses.

We anticipate fielding the Internet survey in April 2013. The evaluation team does not anticipate providing incentives to these participants.

Deliverable: Participant Survey Deliverable *Deliverable Date: April 2013*

Site Visits

Opinion Dynamics will conduct up to 85 site visits. The sample for the visits will be stratified by participant type, class or measure if the sample frame allows. During Phase 2, we will develop our sample stratification logic to ensure that results can be extrapolated to the population of participants. Depending upon the number of completes from the participant survey and their characteristics (i.e. number and type of actions taken, building characteristics, etc.), we may develop a stratified sampling approach to conduct site visits. In addition, if our response rate is too low to support enough site visits, we will draw a sample of site visits from the population of BOC participants.

The scope of each visit will be tailored to the specific measures installed at the site.[52] Table 27 presents the energy saving measures and actions encouraged and quantified through various programs across the country and provides an indication of the actions that we expect to see. Unless otherwise noted, each "X" in the table below relates to the installation of a particular measure. O&M activities related to these measures are also noted by "(O&M)" below the "X".

Table 76. Basis of Savings Quantified by BOC Program

Measures Installed and O&M Changes	BOC Programs				
	NEEA	MN MEEA	KCP&L	NEEP	APS
HVAC	X (I, O&M)	X (I, O&M)	X (I, O&M)	X (I, O&M)	X (I, O&M)
Efficient Motors	X	X	X (I, O&M)	X (O&M)	X (O&M)
Lighting Controls	X	X	X (I, O&M)	X	
Lighting Equipment	X	X	X	X	
Air Compressor		X (I, O&M)	X (O&M)	X (O&M)	X (O&M)
VFDs	X	X	X	X (O&M)	
Energy Management System (EMS)	X	X	X (O&M)		
Economizer	X	X		X (O&M)	
Air Handler Seals			X (I, O&M)	X	X (I, O&M)
Electrical PM	X (O&M)	X (O&M)			
Domestic Hot Water	X	X			
Pipe Insulation			X	X	
Drive Power		X (O&M)			
Building Shell	X (O&M)				
Water System			X (O&M)		

Note: "I" indicates Installed equipment while "O&M" indicates changes to Operations and Maintenance practices.

We will provide a $100 incentive for each site visit to reduce self-selection bias.

[52] Appendix O identifies potential data collection sources by energy savings actions, participant survey or on-sites.

The team will conduct site visits in order to collect additional information to inform the engineering analysis to develop gross energy savings estimates. An engineer will visit the site and verify changes in energy savings actions (replacement or O&M) as well as collect additional information to calculate energy savings as a result of each action. This information may include a verification of installed equipment (or assessment of frequency of O&M practices through a review of EMS data or O&M logs) in addition to verification of building characteristics (i.e., square footage of building, heating type, fuel type, etc.).

We anticipate conducting site visits in April-May, 2013. The budget includes $100 incentives for each site visit as well as travel costs for the evaluation team.

Deliverable: Site Visit Data Collection Instrument *Deliverable Date: April-May 2013*

Engineering Analysis and Gross Savings Estimation

Opinion Dynamics will assess gross energy and demand impacts through an engineering analysis. The engineering analysis will be informed by responses to the participant survey and site visits (as noted above). Engineering analysis will incorporate an assessment of baseline energy efficiency O&M practices and equipment in participant facilities during the program cycle. The analysis will incorporate primary data collected through the evaluation effort as well as secondary sources to develop energy savings estimates from O&M and replacement actions.

For measures with default values (i.e., those coming from the DEER Database), the baseline is embedded in the impact estimate. Bias is expected to be minimal here as the average impact is based on engineering averages across weather zones (where appropriate).

The benefit of this approach is that the impact results can be provided at an energy savings action level, providing key insights into the types of actions that result in the highest savings, and potential future curriculum changes. However, we note that this bottom-up approach relies upon secondary sources and algorithms to determine savings, and will provide summative energy savings values that do not account for interactive effects across actions taken. (See the Appendix 0 to the evaluation plan for information on how to collect additional insights in this area.)

The effort may provide energy savings estimates by participant, company (site address), as well as by IOU and statewide, where sample sizes allow.

We anticipate conducting the engineering analysis and gross savings estimation in May-July, 2013.

Deliverable: Workbook of Engineering Algorithms and Analysis *Deliverable Date: July 2013*

Cross-Program Attribution Analysis

As an additional effort, the evaluation team will also perform a channeling analysis—an examination to determine if and when BOC program participants engaged in IOU EE programs, and what BOC program savings may already be counted in these programs. As such, energy savings that are double-counted in other IOU programs will be deducted from the gross savings estimate.

The evaluation team plans to assess cross-program attribution via participant self-report data collected during the participant survey and/or site visits. We will also work with Itron to see if existing databases will allow us to determine cross program participation through a comparison of databases. We note that it is not clear if the existing databases and data tracking will allow for a cross-program comparison (e.g., account information may not be tracked, customer information/address may not be able to be compared). We anticipate performing the channeling analysis (between April and June

2013). While we have allocated some dollars for this task in the current budget, this effort will need to be conducted on a time and materials basis as the cost for the effort is dependent upon the usability of the program databases, which were not available to the Opinion Dynamics team at the time of this write-up.

Deliverable: None *Deliverable Date: July 2013*

Net Savings Analysis

Opinion Dynamics will identify net savings by incorporating a module within the participant survey to assess program influence on energy savings actions.

The outcome of the effort will be total net savings per participant for the program. Total net savings will be the summation of net savings across all actions taken.

We anticipate performing this analysis after the participant survey information is collected (anticipate June 2013).

Deliverable: None *Deliverable Date: July 2013*

Reporting

Opinion Dynamics will summarize and report data from the evaluation activities in a final report delivered in July 2013. In advance of the final report (April 2013), we will provide an interim memo that provides a status update and findings to date.

Deliverable: Interim Memo *Deliverable Date: April 2013*

Deliverable: Final Report *Deliverable Date: July 2013*

Timeline of Activities

Figure 8 provides a timeline of data collection, analysis, and reporting activities.

Figure 8: Timeline of Evaluation Activities

Task	Evaluation Task	2013						
		Jan	Feb	Mar	Apr	May	June	July
5.2.1	Kick-Off and Finalization of Phase 2 Plan							
5.2.2	Program database review							
5.2.3	Participant Survey							
5.2.4	Site Visits							
5.2.5	Engineering Analysis and Gross Savings Estimation							
5.2.6	Cross-Program Attribution Analysis							
5.2.7	Net Savings Analysis							
5.2.8	Reporting							

	Data Request
	Collect Data
	Analyze Data
	Milestone Deliverable

Evaluation Budget

The evaluation budget for the Phase 2 impact evaluation is $200,000. The following table provides the budget by task.

Table 77: Proposed Evaluation Budget

Task	Evaluation Task	Proposed Budget
5.2.1	Kick-Off and Finalization of Phase 2 Plan	$5,000
5.2.2	Program database review	$2,000
5.2.3	Participant Survey	$20,000
5.2.4	On-Sites	$83,000
5.2.5	Engineering Analysis	$38,000
5.2.6	Cross-Program Attribution Analysis	$15,000
5.2.7	Self-Report NTG Analysis	$7,500
5.2.8	Reporting	$29,500
	Total Budget	**$200,000**

Additional Methodological Approaches Considered

The evaluation team also considered a series of additional optional efforts to estimate BOC program savings. Due to budget constraints, these efforts are infeasible for this program cycle.

Optional Effort: Non-Participant Survey

As an additional effort, the evaluation team could estimate net savings with the alternative approach of surveying non-participants. In this approach, the participant self-report net and the comparison group net values would not be combined and deducted from energy and demand savings estimates, but will be provided as two ratios that could be compared. Using both approaches would provide an assessment of variation across these two methods, which could provide insights to future research. This effort would also provide a baseline of participant actions that could inform the 2013 program evaluation as it can be used as a pre-post survey for actions taken over the course of the 2013-2014 program cycle.

Non-participants would include future program participants, i.e., those participants who have enrolled in BOC training in the 2013-2014 program cycle. This comparison group would limit some selection bias that could occur by using a comparison group of building operators who have not taken and are not interested in taking the course. A review of NEEC's participant data indicates that there are 10 enrollees in 2013-2014 BOC courses; however, we anticipate that more will enroll in the next one to two months. This population size is not sufficient to be able to equivalently match to the participant group. However, we may expect to see the number of enrollees increase in January, which would make it an attractive alternative approach.

Opinion Dynamics will conduct a survey with "non-participants," in this case 2013 program participants. The next BOC 2013 program will begin in March 2013. To assess baseline energy efficiency O&M practices and equipment, we will field a survey to 2013 program participants during their first Level I course. Table 78 provides an overview of expected course start dates by IOU.

Table 78: BOC 2013 Program Level I Start Date

IOU	Level I BOC 1001 Start Date	Location	Potential # of Participants
SDG&E	3/13/2013	Energy Innovation Center, San Diego, CA	20
PG&E	4/23/2013	Eureka, CA	20
PG&E	5/8/2013	Pacific Energy Center, San Francisco, CA	20
SCE	NA, began in September 2012		

We anticipate fielding the paper-based survey to 60 future program participants at the beginning of their Level I 101 course (i.e., conducting a census of each class). We characterize these as non-participants as we will collect data from them on their first day of class. Key members of the evaluation team as well as the client will review all drafts of the various survey instruments.

Similar to the participant survey, the non-participant survey will collect the following information to inform the development of baseline energy efficiency O&M practices and equipment:

- **Energy Savings Actions Taken within Last Year**
  - O&M actions taken, frequency of actions taken (these will be drawn from the 108 actions provided by NEEC)
  - Existing facility equipment and practices (i.e., HVAC, lighting, etc.)
- **Building Characteristics**
  - Square footage of facility that participant is directly responsible for, other building characteristics (age, number of buildings, market sector, heating type, fuel type, etc.)
- **Cross-Program Attribution**
  - Rebates or incentives used for any replaced equipment in previous year
- ***Optional for Billing Analysis:* External Factors and Building Characteristics (*not currently in budget)***
  - Changes made to facility during 2010-2011 such as building occupancy, additional equipment installed, major retrofits, etc.
  - Account number (we will ask for account #'s and provide a card to take back to their facility and mail back to the evaluation team). This data could inform future impact evaluations for the program.

The data collected from this effort will help to develop baseline market O&M practices and equipment in facilities for building operators.

Optional Effort: Statistical Analysis of Customer Billing Data

If customer billing data is available, we propose an additional effort to assess the energy and demand impacts for BOC participants who enrolled from January 2010 to June 2011[53] through a statistical analysis of customer billing data. This approach would be a pre-post billing analysis.

[53] These participants are selected as they will have a sufficient number of pre- and post-billing data.

The evaluation team will assess the feasibility of accessing program participant billing data to estimate energy savings through a statistical analysis of billing data. Feasibility will be determined based upon the ability to collect customer account information through participant surveys, access to billing data, sufficient pre-post billing data, and metered data that is relevant to the square footage of the facility in which energy savings actions are taken. We will work with Itron and the IOUs to provide us with hourly data from January 2010 to November 2012. We can obtain and use weather data from the National Oceanic and Atmospheric Administration (NOAA). We outline the proposed effort below.

To construct a sample frame of attendees, we will exclude any BOC attendees who do not have 12 months of pre-billing data and 12 months of post-billing data. In this case, this would exclude all program participants who enrolled after November 2011. In addition, we will exclude any participants who have made major changes to energy consumption unrelated to BOC participation (i.e., major changes in occupancy, major retrofits unrelated to BOC, etc.)

Once the data are available, we will prepare the data for analysis and generate baseline statistics on the cleaned data. We will use three types of files (i.e., survey data, meter data, and weather) to complete this analysis. The survey data will provide participation information to indicate exactly when the actions began and which devices were installed and functional and will eventually be merged with the billing data.

We will explore energy savings estimated by using more than one model, but expect to use a fixed-effects panel model to estimate net energy savings. The model estimates the average daily change in usage starting after the action(s) is taken compared to average daily usage before participation (during the entire period covered by the usage data). The model also controls for weather effects. This model leverages data available both across customers (i.e., cross-sectional) and over time (i.e., time series) to control for differences across customers, and potential differences across periods in time.

The fixed-effects designation refers to the assumption that differences across customers can be accounted for in large part by customer-specific intercept terms. The fixed effects model is a type of differencing model in which all characteristics of the customer—which (1) are independent of time and (2) influence energy consumption—are captured within the customer-specific intercept terms. In other words, differences in customer characteristics that cause variation in the level of energy consumption, such as building size and structure, or lifestyle (if unchanged over the study period) are captured by constant terms representing each unique customer home.

It is unlikely that the evaluation team would be able to develop a comparison group based upon future BOC participants enrolled in the Level I course for the 2013 program cycle given the inherent difficulties in accessing customer account information during the non-participant survey effort. As such, we are not proposing to conduct a pre-post analysis with a comparison group.

Billing analysis will provide an accurate assessment of facility level gross energy savings during the period of program participation. This assessment would incorporate any interactive effects that result from conducting multiple O&M and replacement efforts as suggested through the BOC course materials.

For the billing analysis, we expect to be able to generalize our findings from the analysis to the population of participants who responded to the participant and non-participant surveys. One bias that can result from billing analysis is misinterpretation of association as causal effects. This potential source of bias comes into play when a regression is used in the analysis. While we understand the issues involved with association versus causal, it is standard practice that billing analyses typically assume regression coefficients estimate causal effects for energy savings. As such, the results of the billing analyses will produce expected energy impacts.

BOC Observation and Interview Findings

Below we provide rough notes from observations of three Builder Operator Certification (BOC) courses attended in winter 2012. We conducted the observations to gain further understanding of what students do and learn in the courses that are relevant to specific actions that can save energy at their facilities. While the full course curriculum consists of a wide variety of topics (

Table 1) we chose to observe these specific courses because they were offered during the time available, i.e., we used a convenience sample for conducting the observations. We also support these general findings with information gathered from BOC/IOU staff interviews, which will be covered more fully in a subsequent evaluation plan for Phase I. We list the courses observed in Table 79.

Table 79: BOC Course Observations

IOU	Center / Host	Location	Date	Course Name
PG&E	Food Service Technology Center	San Ramon	11/13	BOC 1003 Efficient Lighting Fundamentals
PG&E	University of San Mateo, Skyline College	San Bruno	11/15	BOC 202 Advanced Electrical Systems Diagnostics
SDG&E	Energy Innovation Center	San Diego	11/28	BOC 203 HVAC Troubleshooting & Maintenance Part 1

BOC 1003 Efficient Lighting Fundamentals: Participants learn lighting fundamentals and principles of efficient lighting including: evaluation of lighting levels; fixture and control technologies; retrofit and redesign options; and required maintenance to reduce energy use associated with lighting while maintaining recommended lighting levels needed for productivity and safety.

BOC 202 Advanced Electrical Systems Diagnostics: Participants learn a variety of topics intended to improve the quality of electrical systems maintenance. Topics include electrical system monitoring and maintenance, specific technologies to be maintained, power supply issues, energy conservation, and future technologies.

BOC 202 HVAC Troubleshooting & Maintenance Part 1: Participants learn a variety of facility heating & cooling systems, recommend energy saving practices, the dynamic relationship between various loads and machinery, identify tools used in calibrating and calculating airflow, troubleshoot and maintain HVAC systems, and how to apply more specific knowledge in repair situations.

Below we outline our key draft findings:

Attendee Profile

Typical attendees are:

- Operations maintenance staff/technical experts. Occasionally, attendees are managers. There did not appear to be any market actors in the courses we observed.
- It is common for a company to send more than one employee. This is in part because the program incentivizes attendance through a tuition discount for each additional representative. It is unclear whether these employees are responsible for the same square footage/facility.
- Some attendees may specialize in a functional area (i.e., electrician, HVAC, etc.). BOC is a multi-disciplinary course series, and not every participant has responsibilities or expertise relevant to the subject being taught.
- Are not decision makers regarding operations or capital improvements, but may have the skills to present a business case for potential changes.

- One class included a facility manager along with much of her staff. The staff seemed engaged, as the decision maker for their facility was also present and engaged. However, the attendance of a facility decision maker may not be typical.
- Note that our impact methods will need to account for duplication across facility.

- Although attendees are not screened before enrollment, certification ultimately requires two years of experience as either building operations staff, or working in energy management for a commercial or industrial facility. Most attendees are pursuing certification, so this would apply to most attendees who enter the course.
- Institutions/sectors that appeared to be represented in the observed courses included: schools (University of San Mateo, UC Berkeley, UCSF, UCSD, SDSU, CSU), Counties, Cities, Museums, Labs, Private industry.
- After our interview with the BOC coordinator at NEEC, it became apparent that there are a number of useful participant data fields that NEEC does track, which we will include in the full report and may impact sample design. These include:
  - Square footage of facility
  - Market sector
  - Supervisor contact information
- SDG&E will, and PG&E has, offered BOC certification to unemployed operators. This may also roll out to the other energy centers in the 2013 cycle with implications for energy savings. This has a potential impact on savings in 2013 cycle and 2010-2012 evaluation.
  - At PG&E, these attendees were sponsored by building/facility managers to implement actions in a sponsoring facility.

Course Profile

- Courses are structured to provide information on maintenance/operations as well as capital improvements.
- Courses require homework activities in which actions are intended to be applied to facilities.
- There is a close relationship between BOC and California higher education.
  - All three observed courses were heavily attended by staff of California colleges. The California colleges satisfy a number of criteria that BOC looks for when deciding on course sites: geographically diverse, comfortable, adequate parking and can donate space for free. For their part, California colleges often have limited budgets that make energy efficiency improvements attractive.
- According to an interview with BOC administrators, BOC had received a Department of Energy grant with which to develop new course material and integrate this with their existing curriculum. This has taken the form of five classes: one in the Level 1 core list, and four within the supplemental course list. In addition, the content of each course has been updated. The new curriculum will replace the previous Level 1 offerings in 2013. The result is a new curriculum list, which can be seen in
- Table 1.

Below is a brief summary of the activities within each course that was observed.

- The lighting information started at a most basic level, but very quickly built upon it to be comprehensive, and at increasing levels of complexity (which were simplified as much as possible within the topic). Having the assignments, and having some tools available to students (such as foot candle measurements, etc.), crystallized the concept. The instructor asked for questions and class participation frequently.

- The Advanced Electrical Systems Diagnostics course had limited value in terms of energy efficiency, but significant value in terms of electrical reliability and equipment maintenance. The instructor provided many concrete examples of tools and equipment issues that should closely translate to student facilities. Of all students attending this course, one was a management decision maker. Her hope was that her team would save money and energy by improving the overall quality of maintenance and operations.
- The students in the HVAC course considered the information more theoretical than applied and expressed doubt that many of the measures would be implemented, since the students were not decision makers within the organization. However, the instructor was very experienced and engaging, and showed specific tools available in the tool lending library that would improve efficiency and help maintain their facilities.

Actions Profile

Actions fall into two categories: 1) Maintenance/operations, and 2) Replacement.

There are a number of actions that have been identified, categorized, and ranked by energy saving potential by NEEC. We are in the process of securing this information. We will discuss these actions at length in the evaluation plan.

Homework assignments, required for each class, provide the ability to identify facility baseline and recommended improvements. Each student is provided a binder that contains homework instructions, as well as captures each participant's building characteristics. This information is collected by instructors, but is the property of the student and is not kept by BOC after having been graded.

Instructors sometimes discuss IOU EE rebate programs in connection with the course. According to in-depth interviews, the level of integration with EE rebate channeling is different across the IOUs. Notably, one homework (as discussed below) asked for attendees to research IOU incentives.

- BOC 1003: An IOU representative reportedly speaks about various utility rebates at the beginning of the first session of the multi-series courses for about 20 minutes.
- BOC 202: Instructor said that IOUs have been invited to come to speak to the classes about options, but that instructors rarely do, since programs are IOU specific and instructors teach courses in multiple geographic areas.
- BOC 203: Instructor discussed VFDs and incentive available through SDG&E.

These are examples of potential actions taken, based on the homework assignments of the courses we observed:

- BOC 1003: Conduct a lighting survey for a space or building. Research local utility incentives and calculate the rebate and return on investment for a lighting retrofit project.
- BOC 202: Describe a power quality upgrade plan for your facility or for part of your facility. Detail how you would set up and implement a power quality survey in your facility. If this has already been done, detail how this was achieved.
- BOC 203: By comparing original design and operating conditions to actual conditions that exist in the facility, participants can identify items that can and/or should be controlled and adjusted, as well as improvements that have been made or maintenance that is needed (O&M improvement).

There was an emphasis on asking students to apply what they have learned in class to their own buildings, both in class activities and in the required homework project.

Proposed Data Collection for Future Program Cycle Evaluations

As can be seen in Figure 7, the BOC program currently collects some participant information at each stage of the program. BOC should continue to collect this information. However, additional information can help to inform impact evaluation efforts for the 2013-2014 program cycle, as well as to inform sample designs going forward.

The evaluation team developed a set of proposed data collection items for the IOUs and NEEC to offer to future program participants. These were developed based upon conversations with IOU contract administrators, NEEC program staff, and informal conversations with course instructors during observations of courses.

This data is in addition to data already collected. Below is a brief summary of these data points, organized by which stage in the program that it would be most beneficial to collect them.

General – Any Stage

This data could be collected at any stage, though preferably at registration. Participants can be reasonably expected to know this information on their own.

- Hours of Operation – Both weekly schedule and in which the facility is inactive for more than half of the month
    - This would allow for more accurate usage calculations for each individual participant
- If the facility owns, leases or is managed by the participants company
    - This would allow insight into effective incentives for energy management within the facility
- If the participant has direct influence over energy management decisions at their facility

Course Homework

This data could be collected in conjunction with specific coursework assignments. Many participants will not know this information without additional effort.

- Precise square footage of both the facility and the portion of the facility for which the participant is responsible
    - This would enable more accurate energy use calculations
- Number of other facility employees that will be BOC certified after the completion of the current curriculum
    - This would enable evaluators to better determine the degree of influence that the BOC program has had on energy savings
- Primary utility account number or numbers
    - This would allow evaluators to more effectively track impacts within individual companies, and to track companies with multiple representatives who have attended BOC.

Potential Energy Savings Actions

NEEC provided the evaluation team with a list of measure categories and course numbers that will facilitate the development of our survey instruments (See table below).

Measure Category / Measure Name	BOC Course	Proposed Data Collection Source S = Survey O = On-site
Boiler/Hot Water/ Steam System		
Tune up boiler	BOC103	S
Install hot water pump VFD	BOC103	S
HW Supply Temp Reset	BOC103	O
Install combustion fan VFD	BOC103	S
Test and replace faulty steam traps	BOC103	S/O
Reset supply water temperature based on load	BOC103	O
Replace conventional gas boilers with condensing boilers	BOC103	S
Minimize blowdown of steam boilers	BOC103	O
Monitor makeup water for steam boilers	BOC103	O
Monitor pump operating pressures	BOC103	O
Match boiler capacity to load with multiple boilers or high turndown ratio	BOC203	O
Implement heat recovery with exhaust gas heat exchanger	BOC203	S
Insulate steam and water piping	BOC103	S
Chiller / Chilled Water System		
Balance water side	BOC103	O
Chilled water temperature reset based on load	BOC103	O
Optimize chiller sequencing	BOC103	O
Maintain operating logs	BOC103	O
Monitor pump operating pressures	BOC103	O
Use water side economizer	BOC103	S
Insulate chilled water piping	BOC103	S
Thermal storage systems	BOC103	S/O
Install evaporative cooling system	BOC103	S/O
Optimize part load efficiency with multiple chillers or variable speed compressors	BOC203	O
Measure and optimize chiller performance	BOC203	O
Install absorption cooling systems	BOC203	S
Cooling tower optimization		
Reset condenser water temperature	BOC103	O
Condenser water temperature optimization	BOC203	O
Misc. cooling tower optimization	BOC103	O
Cooling tower maintenance to for optimum operation	BOC103	O
Use variable speed condenser fans for capacity control	BOC203	S/O
Domestic Hot Water		
Install low-flow faucets, shower heads and pre-rinse spray valves	BOC105	S
Install tankless water heaters	BOC101	S
Install solar water heating	BOC103	S
Economizer and Ventilation control		
CO-based ventilation control	BOC103	O
CO2 based Demand control ventilation	BOC103/BOC203/ BOC204	O
Use economizer and outdoor air control	BOC103/BOC203/ BOC204	O

Reduce ventilation	BOC103	O
Repair economizer	BOC103/BOC 203	O
Schedule heaters	BOC103	O
Reset supply air temperature	BOC103/BOC204	O
Use natural ventilation	BOC103	O
Building pressurization control	BOC103	O
Night purge cycle for pre-cooling	BOC103/BOC203	O
Economizer commissioning	BOC103/BOC204	O
Heat recovery systems	BOC103	S/O
Equipment Scheduling		
Optimum start for AHU	BOC103/BOC203/ BOC204	O
Match AHU schedule to space occupancy	BOC103	O
Schedule boilers	BOC103	O
Schedule exhaust fans	BOC103	O
Schedule fan-powered boxes	BOC103	O
Schedule fan-powered/VAV boxes	BOC103	O
Schedule heaters	BOC103	O
Schedule pumps	BOC103	O
Schedule return/exhaust fans	BOC103	O
Set back space temperature (electric baseboard)	BOC103	O
Reset supply air temperature	BOC103	O
Fan optimization/Air Distribution		
Balance airside	BOC103	O
Demand control ventilation	BOC103	S
Reduce/reset duct static pressure	BOC203	O
Install efficient filters/Filter maintenance	BOC103/BOC203	O
Optimize supply fan performance	BOC203	O
Optimum start for AHU	BOC103	O
Reduce simultaneous heating and cooling	BOC103	O
Reduce VAV minimum position	BOC203	O
Reduce ventilation	BOC103	O
Repair/replace dampers	BOC103	O
Schedule AHU and duct static pressure reset	BOC204	O
Schedule AHU for space	BOC103	O
Schedule return/exhaust fans	BOC103	O
Reset supply air temperature	BOC103	O
Utilize VFDs for fans	BOC103/BOC203	S/O
Clean heat exchangers and coils	BOC103	O
Commission air systems	BOC103	O
Seal ductwork	BOC103	S/O
Insulate ductwork	BOC103	S/O
Building warm-up cycle	BOC103/BOC204	O
Lighting		
Match schedule to occupancy/Schedule lighting	BOC101/BOC102	O
Utilize daylighting	BOC102/BOC105	O
Reduce lighting loads (do not overlight)	BOC105	O
Reduce lighting loads (use efficient sources)	BOC105	O

Commission control systems	BOC101/BOC105/ BOC203/BOC204	O
Schedule/Conduct Lighting Audit	BOC104	O
Install occupancy sensors	BOC104	S/O
Install vacancy sensors	BOC104	S/O
Install photocells on interior fixtures (skylights/window walls)	BOC104	S
Install lighting control panels (sweep/timers)	BOC104	S
Replace magnetic T12 fluorescent ballasts with electronic ballasts and T8/T5 lamps (CEE)	BOC104	S
Replace HID fixtures with EE technology	BOC104	S/O
Replace standard wattage T8's with reduced wattage T8's	BOC104	S/O
Replace F54T5HO's with reduced wattage T5HO's	BOC104	S/O
Replace incandescent exit signs with LED	BOC104	S/O
Replace incandescent lamps with CFL/LED	BOC104	S/O
Install new high-efficiency fixtures (80%+ efficacy)	BOC104	O
Replace stairwell lights with bi-level fixture w/sensor	BOC104	S/O
Re-lamp and clean fixture housings and lenses	BOC104	O
Evaluate exterior lighting for replacement/retrofit opportunities	BOC104	O
Evaluate exterior lighting for control savings	BOC104	O
Pump optimization		
Adjust freeze protection sequence for pumps	BOC103	O
Impeller trimming	BOC103	S
Improve CHW and HW flow control	BOC103	O
Reduce flow by increasing system Delta T	BOC103	O
Schedule pumps	BOC103	O
Utilize VFD for pumps	BOC103	S/O
Energy Accounting		
Determine facility EUI; conduct energy use analysis	BOC101/BOC102/ BOC105	O
Use Energy Star Portfolio Manager to benchmark building performance	BOC101/BOC102/ BOC105	S
Apply for Incentives/Tax Credits		
Determine potential EE project (scope of work defined)	BOC102/BOC105	S
Contact utility representative	BOC102/BOC105	S
Obtain bids/pricing for scope of work	BOC102/BOC105	S
Research funding available from utility programs	BOC102/BOC105	S
Research available State tax credit programs	BOC102/BOC105	S
Research available Federal tax credit programs	BOC102/BOC105	S
Obtain necessary pre-approval application from local utility	BOC102/BOC105	S
Complete and submit application for pre-approval	BOC102/BOC105	S
Complete project	BOC102/BOC105	S
Obtain necessary payment application from local utility	BOC102/BOC105	S
Complete and submit information for payment from local utility	BOC102/BOC105	S
Complete and submit information for tax credits	BOC102/BOC105	S
Other		
Implement renewable energy to reduce utility energy consumption	BOC105	S/O
Minimize plug loads	BOC101/BOC105	O

Envelope efficiency improvements (insulation, cool roofs, air sealing, etc.)	BOC101/BOC103	S/O
Install high efficiency condensing boilers and furnaces	BOC103/BOC203	S
Implement net-zero strategies	BOC105	O
implement a conservation policy	BOC105	O

Bibliography of Evaluation Reports

Below we provide a bibliography of the evaluation reports reviewed to inform the development of the evaluation plan.

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