2013–2015 Multifamily Property Manager Training: Impact and Outcome Study

Energy Division
California Public Utilities Commission

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Prepared by

Opinion Dynamics

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Opinion Dynamics

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Prepared under the direction of the **Energy Division** for the

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Submitted by:

Opinion Dynamics
1999 Harrison Street, Suite 1420
Oakland, CA 94612
aelliott@opiniondynamics.com
(510) 444-5050

Tory Francisco, CPUC Project Manager
tory.francisco@cpuc.ca.gov
(415) 703-2743

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1. Executive Summary

Study Overview

This study explored the energy and non-energy outcomes associated with Building Operator Certification (BOC) and Building Performance Institute (BPI) training for multifamily (MF) property owners, managers or other maintenance staff (collectively referred to henceforth as "MF staff"). Specifically, this study explored the energy savings potential from the trainings related to operations and maintenance (O&M) practices and energy efficiency retrofits. In addition, this study explored non-energy outcomes such as knowledge gain, participation in resource programs, career benefits, and tenant satisfaction.

Research tasks included participant internet surveys with 13 BOC and BPI MF staff participants (11 BPI and 2 BOC) and four follow-up in-depth interviews with four BPI participants. The survey explored energy savings actions taken by their companies post-training, training influence on those actions, building characteristics, motivations/barriers to training, and non-energy outcomes of the training. The follow-up in-depth interviews collected more detailed information on these topics. Using these data, we completed four case studies of participants that calculated gross and net savings, as well as documented the motivations and non-energy benefits of the training. Additionally, to understand how BOC and BPI training compares with offerings from the California Multifamily Whole Building programs, we conducted in-depth interviews with program implementation staff at the Investor-Owned Utilities (IOUs), Regional Energy Networks (RENs), and Marin Clean Energy (MCE).

Notably, findings, conclusions, and recommendations from this study are largely based on a relatively small sample of BOC/BPI participants (n=13). Impact estimates were developed using a case study approach and only included four respondents. Thus, the results of this study cannot be generalized to the larger BOC/BPI participant population or to the broader market of MF staff.

Hard-To-Reach Nature of MF Property Managers

This study faced significant challenges related to the hard-to-reach nature of the multifamily market during data collection. MF staff are particularly challenging to engage in research, as they are often unresponsive or claim they are too busy to engage in research. The best ways to reach and engage MF staff in energy efficiency-focused research remains uncertain. Among known BPI-trained MF staff, we were able to get 13 out of 120 MF staff to take the initial internet survey. Obtaining just these 13 respondents required multiple email solicitations, multiple phone calls and an offer of an $50 incentive. Throughout the surveying, we found that some had changed jobs and were no longer reachable but many were not interest despite multiple touches and incentive offerings. In addition, after several phone calls and offering up to $150 in additional incentives, we were only able to get four of the 13 survey respondents to agree to further data collection for a case study.

Introduction to BOC and BPI Training

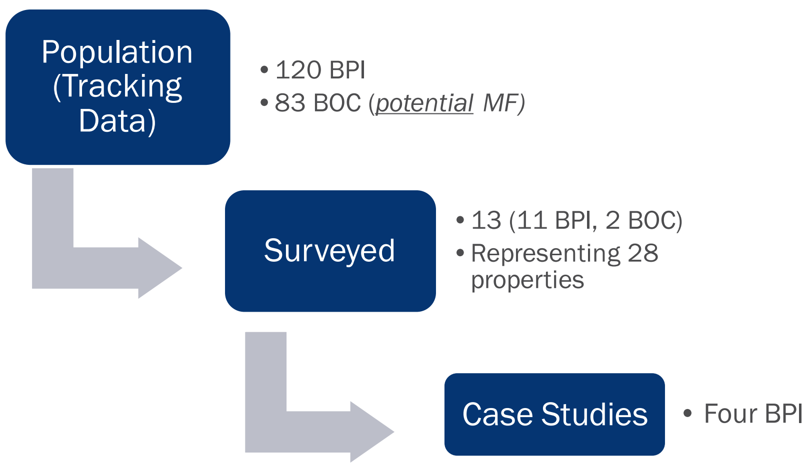
BOC is a nationally recognized energy efficiency training and certification program funded by the California IOUs and administered by the Northwest Energy Efficiency Council (NEEC). BOC combines classroom training, exams, and in-facility project assignments to train and certify attendees in the practice of energy efficient building O&M. Key topics include building systems equipment (with an emphasis on HVAC controls), common opportunities for operational improvements, and building scoping for energy efficiency.

BPI is a national standards development organization for residential energy efficiency and weatherization retrofits. BPI offers specific certification for multifamily building operators (MFBO). The Association for Energy Affordability (AEA) is the only organization that offered MFBO training courses in California in 2013-2015. The

2013-2015 BPI MFBO training included classroom training and a visit to a multifamily property. BPI organizes topics into five modules centered around energy efficient building O&M. These include Building Science, Auditing/Reporting Skills, Inspection and Diagnostic Skills, Installation/Analysis Skills, and Health and Safety.

Between 2013 and 2015, 631 participants attended the BOC training and 120 attended the BPI MFBO training. All the BPI participants are MF staff. However, because BOC primarily targets commercial building operators, BOC does not specifically track which participants are from the multifamily versus the commercial sector, making it unclear how many MF staff attended the training. Through a review of available data, participants' companies' websites, and Google Maps imagery, we identified 83 potential MF staff who attended the BOC training (13% of all BOC trainees). Notably, the relatively low incidence of MF staff that took BOC, in combination with these data limitations, were the major drivers of the small BOC response to the participant survey (two respondents). Figure 1 summarizes the results of our data collection efforts.

Figure 1: Summary of Data Collection Results



Participant Characteristics and Motivations for Taking the Training

The 13 survey respondents represented a diverse mix of properties across the state. Most respondents (8 of 13) said their company owns at least some of the properties they oversee, with a mixture of non-profit and private owners. According to the U.S. Census[1], most properties (24 of 28, or 86%) are classified—in terms of number of units—as large multifamily properties. Additionally, there was a high concentration of low income housing. Notably, many respondents did not know their properties' total square footage or annual energy costs.

Respondents typically hold a key decision-making position at the company. Titles varied widely, ranging from high-level positions like "regional manager" or "owner" to supporting positions such as "property management

[1] A large multifamily property is defined as 50 or more units. Source: American Community Survey Three Year Estimates 2009-2011 (U.S. Census Bureau 2011)

assistant". Overall, when asked on a scale of 0 to 10, with 0 being "no influence at all" and 10 being "a great deal of influence" on investment decisions[2] most (8 of 13) cited they had "8" or greater influence.

Many respondents initially took the training because it was a requirement of their employer (7 of 13). In the case studies, companies were motivated by state and local requirements (e.g., city ordinances and state levies for excessive water use) as well as low-income tax credits and, in one case, the improved company image by going "green." Notably, at the time of the training, a Low Income Housing Tax Credit (LIHTC) was available for properties that had a BPI-certified staff. However, this tax credit is no longer available, which may impact the likelihood of companies to seek BPI training in the future.

Energy Savings Actions Taken and Gross Savings

Survey efforts identified 11 out of 13 training participants who took actions post-training. Among these 11, lighting and domestic hot water upgrades were most common. Notably, while the BPI/BOC trainings focus on O&M, the energy savings we found are exclusively coming from retrofit (i.e., equipment and control) upgrades versus O&M actions (e.g., changing control settings). However, as we highlight in our case studies, many participants applied what they learned to identify potential problems and upgrade opportunities and the training is taken in advance of planned upgrades to optimize their effectiveness.

As presented in Table 1 below, the BPI training[3] does have the potential to provide some additional energy savings in the multifamily sector, though it is often not the main driver of energy savings actions (as shown by the lower net-to-gross ratio (NTGR) in three cases). All four respondents were already planning retrofits to some extent, which limited the overall influence of the training. However, we found that the training generated some additional savings by enhancing these retrofits, either by informing decision on what technologies to choose or optimizing the implementation of the projects.

Table 1. BPI Training Gross and Net Savings Summary

Case Study	Actions Summary	Gross Savings			Savings-Weighted* NTGR	Net Savings		
		kWh	kW	Therms		kWh	kW	Therms
1	LEDs, fans-control devices, water pump controls, Low-flow devices	332,424	92.72	21,518	0.15	49,864	13.91	3,228
2	LEDs, motion sensors, water pumps, refrigerators, water heaters	156,844	7.75	2,274	0.38	58,856	2.08	782
3	Boilers, boiler controls, low-flow devices	0	0	1,703	0.67	0	0	1,135
4	LEDs	524	0.049	0	0.10	52	0.005	0

*We calculated a NTGR for each action category a respondent took (e.g., lighting, domestic hot water). The overall case study NTGR is weighted based on the savings from each category.

Many of the actions taken were incentivized or companies were provided free measures through IOU programs, such as the Energy Savings Assistance (ESA) and Multifamily Energy Efficiency Rebate (MFEER)

[2] Specifically, we asked about influence on investments in new equipment, equipment repairs, or operations and maintenance practices at the properties they oversee.

[3] Notably, no BOC participants responded to our in-depth interview requests and only two responded to the survey. Thus, we are unable to make conclusions about the energy savings potential of BOC training in the multifamily sector.

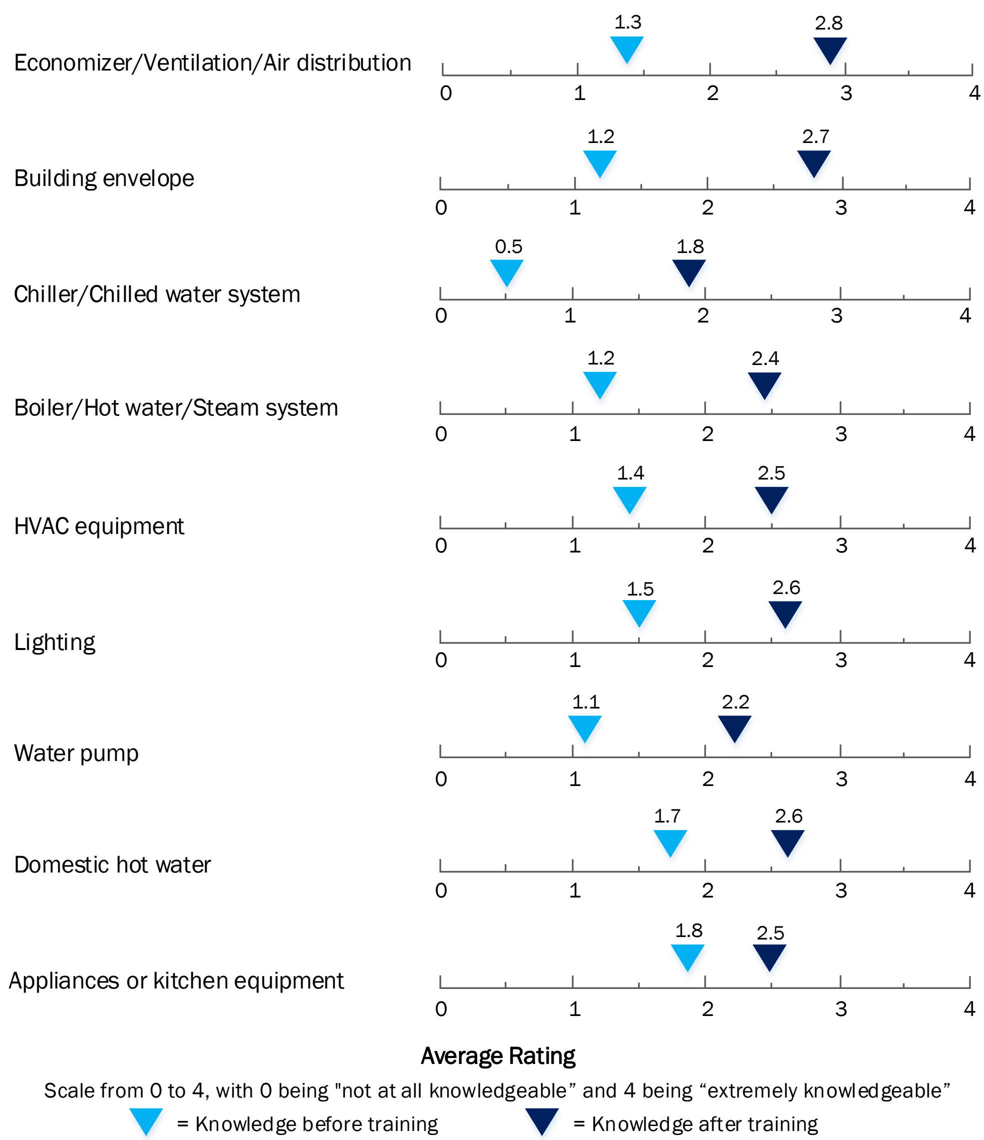
programs. In one case study, no actions were incentivized. Across the other three case studies, between 4% and 100% of savings are already captured by IOU programs.

Non-Energy Outcomes

The value of the training goes far beyond energy savings. Companies experienced a wide variety of financial and non-financial benefits from the training, such as decreased O&M costs (10 of 13), improved health and safety (9 of 13), and increased tenant satisfaction or comfort (8 of 13). The training was beneficial to the careers of many participants, including gaining a competitive advantage on the job market (9 of 13), promotions at their current company (7 of 13), increases in pay at their current company (3 of 13), or a higher pay or position at a new company (3 of 13).

The training was also valuable in increasing MF staff's capacity to conduct O&M in-house (9 of 13), especially in terms of understanding energy efficient (EE) technologies, analyzing building systems, detecting issues, and improving maintenance practices. In the survey, respondents were asked to rate their knowledge of various system categories before and after the training. As shown in Figure 2, respondents typically rated their knowledge as below average (between 1 and 2 on a scale from 0 to 4) before the training and then rated themselves as above average (between 2 and 3 on a scale from 0 to 4) after the training. Further, most respondents (11 of 13) shared the knowledge they gained from the training with staff at their company involved in O&M.

Figure 2. Knowledge Gained by the BPI/BOC Training (n=13)



Comparison with Whole Building Multifamily Programs

In our discussions with Whole Building Multifamily program implementers, we found that O&M training is not a formal part of their program, as the programs do not incentivize O&M practices. However, all PA implementation staff we interviewed mentioned that informal, "over-the-shoulder" O&M advice is commonly provided during on-site assessments. This advice is provided on an ad hoc basis depending on the O&M staff's interest in the assessment, the implementer's observations on-site, and the new measures that the facility is considering. Common themes across all programs included discussions of how equipment and systems work, routine preventative maintenance (such as cleaning, tune-ups, or changing filters), and optimal equipment controls and settings.

In this sense, the topics discussed during Whole Building program on-site assessments naturally align with the BOC/BPI training curriculum. However, what distinguishes these offerings is the level at which information is delivered. The BOC/BPI training provides a much broader overview of building science, systems, and routine O&M. The Whole Building programs, on the other hand, focus on facility-specific needs or properly maintaining specific equipment, usually the equipment to be installed through the program. For instance, this might include how to manage inventory practices for new lighting fixtures or how the proposed new equipment would affect settings, controls, and maintenance schedules.

While the BOC/BPI training is highly valuable for enhancing O&M, it is not sufficient nor intended to replace the expertise provided by contractors/raters/building analysts or the modeling they provide to calculate estimated energy savings and financial payback. Thus, there is an opportunity to take advantage of the synergies between BPI/BOC training and the Whole Building programs to provide a comprehensive package of services to MF staff. Pairing the training with the Whole Building program has the potential to enhance participants' understanding of the recommended upgrades, their benefits, and how to properly maintain the upgraded systems after installation.

Conclusions and Recommendations

The limited number of survey respondents ultimately prevented this study from making generalizable conclusions about the value of BPI and BOC training. However, our findings do suggest that the additional O&M training has the potential to deliver energy savings and non-energy benefits to the multifamily sector. Thus, we recommend that the CPUC and/or IOUs conduct further research into this area. Specifically, we recommend the following:

- **Focus on BPI MFBO training:** We recommend that future research focus specifically on BPI MFBO training, as this is a training attended predominately by multifamily building owners, managers, and maintenance staff. Through we found some evidence that the BOC training includes some MF staff, the BOC training primarily targets commercial building operators. Further, NEEC does not have the data tracking systems in place to properly identify multifamily participants. Should the CPUC and/or NEEC seek to determine the energy savings potential of BOC training in the multifamily sector, additional data tracking will be necessary to identify multifamily participants. Most importantly, NEEC should consider including an identifier flag in the data that indicates whether a participant oversees or maintains a multifamily property. With this data, future evaluations can identify MF staff by looking for "multifamily" participants in the "property management" or "other" categories.

- **Identify strategies for increasing response rates:** Lack of interest or time among multifamily staff to participate in research, regardless of the incentive offered, is a known challenge in the industry and was a significant limitation for this study. Thus, before any further research is conducted, we recommend that the CPUC and IOUs collaborate with multifamily program implementers, training providers (e.g., AEA and NEEC), and other industry organizations to identify improved strategies to engage and motivate multifamily staff to participate in research (e.g., survey mode, survey length, outreach methods, incentive types and levels, best times to contact them, etc.). These types of organization can provide expertise on outreach strategies to this sector and can serve as credible messengers for research efforts.

- **Include non-participants to fully understand training needs:** This study was intended to understand the motivations and benefits to O&M training among training participants and their companies. The study also gathered insights from multifamily program implementers to understand potential O&M training needs in the market. The next step would be to get a full picture of O&M training needs and barriers to getting training in the multifamily market by including MF staff who have not received any O&M

training. This research should also explore whether the BPI MFBO and/or BOC's list of course topics align with those needs. For example, some systems (e.g., boilers and chillers), may not be applicable to the majority of California multifamily properties.

- **Cost comparison:** The CPUC should compare the costs of providing additional O&M marketing, education and outreach (ME&O) to the costs of incentivizing BOC/BPI training. Marketing might be a more cost-effective alternative. While this was not a key focus of this study, we collected a few basic facts as a starting point. In 2013-2015, the BOC training cost $1,495 for California residents. AEA's BPI training typically[4] costs $1,200 with an additional $750 exam fee. Insufficient data was available to assess the ME&O costs per-participant for the Multifamily Whole Building programs.

[4] Notably, the AEA provided the MFBO training for free in 2013-2015 due to IOU program funding. This cost estimate is based on a review of the AEA website's list of course offerings as of October 6th, 2017.

2. Introduction

This study explored the energy and non-energy outcomes associated with Building Operator Certification (BOC) and Building Performance Institute (BPI) training for multifamily (MF) property owners, managers or other maintenance staff (collectively referred to henceforth as "MF staff"). Specifically, this study explored the energy savings potential from the trainings related to operations and maintenance (O&M) practices and energy efficiency retrofits. In addition, this study explored non-energy outcomes such as knowledge gain, participation in resource programs, career benefits, and tenant satisfaction.

This study focused specifically on MF staff who attended BOC or BPI training courses in California in 2013, 2014, or 2015. Notably, this study focused on any MF staff that attended these trainings, regardless of whether they received certification. For BOC, all participants in our study received certification as well as took training courses. For BPI, however, some participants were not certified but still acquired skills or knowledge from the training that led to energy and non-energy outcomes.

2.1 Overview of BOC and BPI Training

Next, we provide a brief description of the BOC and BPI trainings. Please refer to Appendix A for a detailed description of the trainings. Appendix B and Appendix C provide further information on the energy-saving actions and topics covered by the trainings.

BOC is a nationally recognized energy efficiency training and certification program funded by the California Investor-Owned Utilities (IOUs) and administered by the Northwest Energy Efficiency Council (NEEC). The program provides in-depth and hands-on experience to professionals with two or more years of experience in the building O&M field. BOC combines classroom training, exams, and in-facility project assignments to train and certify attendees in the practice of energy efficient building O&M. The program provides two levels of training and certification, both designed to improve job skills and lead to improved comfort and energy efficiency at participants' facilities. Level I is an eight-day course series which focuses on expanding knowledge of building systems equipment and best practices for their efficient operation, with an emphasis on Heating Ventilation and Air Conditioning (HVAC) controls, common opportunities for operational improvements, and building scoping for energy efficiency. Level II is a subsequent series of classroom courses that emphasize preventative maintenance and more targeted training.

BPI is a national standards development organization for residential energy efficiency and weatherization retrofit. BPI offers specific certifications for multifamily building operators (MFBO). The Association for Energy Affordability (AEA) is the only organization that offered MFBO training courses in 2013-2015. The 2013-2015 BPI MFBO training included classroom training and a visit to a multifamily property. BPI organizes the topics tested in its MFBO accreditation into five modules centered around energy efficient building O&M. These include Building Science, Auditing/Reporting Skills, Inspection and Diagnostic Skills, Installation/Analysis Skills, and Health and Safety.

2.2 Study Objectives

This study addressed the in the four objectives and research questions shown in Table 2[5]. The table also provides the report sections where each research question is addressed.

Table 2. Research Objective Crosswalk

Study Objective	Research Question	Report Section(s)
Objective 1: Quantify the Energy Saving Potential of Multifamily O&M Training	What are the energy savings per participant?	4.1.3 and 4.1.4
	How likely were MF staff to have achieved the savings without BOC or BPI training?	4.1.2 and 4.1.4
	Do other resource programs' already capture BPI/BOC savings?	4.1.4
Objective 2: Identify the Non-Energy Benefits of Multifamily O&M Training	What are the non-energy benefits of BOC/BPI training for MF staff? Examples of potential non-energy benefits include workforce development benefits or other business benefits such as increased tenant satisfaction.	4.1.4 and 4.2
	Have MF staff changed jobs since taking the training? If so, are they playing the same or similar roles at their new job? Have they applied what they learned from the training at their new position?	4.1.4 and 4.2
Objective 3: Explore the Barriers and Opportunities to Practicing Optimal O&M Procedures and/or EE Retrofits in Multifamily Properties	What actions are typically taken and why?	4.1.1 and 4.1.4
	What actions are typically not taken and what additional support do MF staff need to allow for more EE O&M practices or retrofits?	4.3
Objective 4: Understand How Training Content Might Overlap or Fill a Gap in the Marketplace	How do the BOC/BPI training topics compare and contrast to the technical assistance topics provided by the IOU, Regional Energy Network (REN), and Marin Clean Energy (MCE) Whole Building Multifamily programs? Is it redundant for the program administrators to offer technical support to BOC/BPI participating properties?	4.4 and interim memo in Appendix G
Additional Research Questions to Inform Evaluation Planning	What concepts do the BOC and BPI trainings teach? How do they compare and contrast?	2.1, Appendix A, Appendix B, and Appendix C
	What are the costs associated with attaining and maintaining each certification?	Appendix A
	Are there improvements that could be made to NEEC or AEA's data tracking practices that would help identify which participants are multifamily facilities (BOC only) or quantify energy savings (both BOC and BPI)?	Appendix A

[5] Notably, the original research plan included three additional questions: "How do savings results compare between BPI and BOC?", "Does BOC/BPI participation vary by property size, geography, market sector, or other characteristics?", and "What are the energy savings per property and per square foot?". As we noted in the research plan, our ability to answer the first two questions was highly dependent on having enough BOC and BPI sample. We ultimately could not address these questions because only two BOC participants responded to our survey. The third question was for the purposes of examining trends across a large group of respondents. Because we calculated savings for only four participants, this topic was not explored and savings were instead estimated for each respondent across all the properties they manage.

2.3 Report Structure

In the remainder of this report, we provide the following information:

- A summary of the evaluation approach and research activities, including data sources and limitations (Section 3)
- A summary of key findings from research activities (Section 4)
- A summary of conclusions and recommendations for CPUC staff (Section 5)
- Appendix A through Appendix C provide detailed descriptions of the BOC and BPI trainings and data availability
- Appendix D provides additional survey data on respondents' professional and property characteristics
- Appendix E and Appendix F provide detailed methods behind the calculations of gross and net savings, respectively
- Appendix G provides an interim memo with detail on Program Administrator (PA) interview findings and data collection instruments from the participant survey and in-depth interviews
- Appendix H provides the study recommendations in CPUC Impact Evaluation Standard Reporting (IESR) format.

3. Evaluation Methods

3.1 Methods Summary

In this section, we discuss the evaluation tasks in this study. Table 3 below summarizes the tasks and objectives.

Table 3. Research Tasks

Research Task	Study Objectives Addressed	Timing	Description
Review of BOC/BPI Programs, Data and Materials	N/A—Evaluation Planning	Jun - Sep 2016	Preliminary research to better understand the BOC and BPI trainings and inform the evaluation plan.
Review of PA Technical Assistance	3 and 4	Jan 2017	Conducted seven interviews with implementation staff from IOU (four), REN (two), and MCE (one) Whole Building Multifamily programs; explored O&M topics covered through programs and discussed O&M needs and barriers among MF staff
Participant Internet Survey	1, 2, and 3	Jan - Mar 2017	Completed surveys with 13 BOC/BPI training participants (two BOC, 11 BPI); covered topics such as actions taken post-training and training influence, building characteristics, motivations/barriers to training, and non-energy benefits of the training
Participant In-depth Interviews	1, 2, and 3	Jun - Jul 2017	Completed four in-depth interviews with MF training participants who indicated in the survey they took action post-training; collect additional detail on actions taken and property characteristics for the impact analysis and dove deeper into the decision-making process within their company, the influence of the training on the actions taken, and the benefits of the training
Gross Savings Analysis	1	Jul - Aug 2017	Requested IOU program tracking data and applied IOU-claimed savings (electric, demand, and gas) for actions incentivized through IOU multifamily programs. For actions that were not incentivized, conducted engineering analysis using assumptions provided by participants to calculate custom gross savings.
Net Savings and Channeling Analysis	1	Jul -Aug 2017	Used self-report survey data on training influence to develop free-ridership scores; determined what proportion of gross savings is already claimed by IOU multifamily programs

3.1.1 Review of BOC/BPI Programs, Data and Materials

As a part of developing the study's evaluation plan, we conducted interviews with NEEC and AEA to better understand the BOC and BPI trainings. Following the interviews, we reviewed program tracking data and materials (e.g., curriculum, lesson plans, course schedules) to develop detailed training descriptions, lists of topics covered, and develop the survey sample. Appendix A through Appendix C contain the results of this effort.

3.1.2 Review of PA Technical Assistance

We conducted in-depth interviews with implementation staff for six Whole Building Multifamily programs offered by the IOUs, RENs, and MCE. Each of these programs provides or incentivizes facility walk-throughs and energy assessments that help customers develop scopes of work for whole building retrofits. The purpose of these interviews was to determine what sort of O&M information and training, if any, is delivered through these programs and if it overlaps with what is taught in the BOC/BPI trainings. We also explored common O&M training and EE retrofit needs and barriers among MF staff. We conducted interviews with the implementation staff of the programs listed in Table 4 below.

Table 4. Programs/Organizations Included in Interviews

PA	Whole Building Program Name	Implementation Organizations
Bay Area Regional Energy Network (BayREN)	Bay Area Multifamily Building Enhancements	• AEA • StopWaste
Pacific Gas and Electric (PG&E)	Multifamily Upgrade Program	TRC Solutions
Southern California Edison/Southern California Gas Company (SCE/SCG)	Energy Upgrade California® Multifamily	• AEA • Partner Energy • TRC Solutions
San Diego Gas and Electric (SDG&E)	Multifamily Whole Building Program	Richard Heath Associates (RHA)
Southern California Regional Energy Network (SoCalREN)	The Energy Network Multifamily Program	• ICF • Build It Green • Bki
Marin Clean Energy	Multifamily Energy Efficiency Program	AEA

3.1.3 Participant Internet Survey

We conducted an internet survey of MF staff who attended BOC or BPI training courses. The key goals of the survey were to:

- Verify training participation and MF status;
- Understand at a high-level the O&M and retrofit actions taken since completing BOC/BPI training, the influence of BOC/BPI training on the decision to take those actions, motivations and barriers to taking actions, and non-energy benefits;
- Collect information on building characteristics, workplace responsibilities, and employer support of BPI/BOC certification;
- Confirm participation in PA multifamily programs; and
- Understand actions taken to maintain certification (if applicable) and the costs of those actions.

The evaluation team attempted surveys with a total of 176 training participants. We completed surveys with 13 participants, representing 28 different multifamily properties. Initially, respondents were recruited for the survey via email, but, following a low response, we attempted to contact participants via telephone. Based on discussions with the BPI and BOC implementers and California Whole Building Multifamily program staff (see

Section 3.1.1), we suspect that this low level of response is driven by the hard-to-reach nature of the MF market. Specifically, there is high staff turnover who are extremely busy throughout the day. Additionally, it appears that much of the contact information for participants was no longer valid[6].

Despite a similar number of starting sample points, there were fewer BOC survey completions. A significant driver of this small number of BOC respondents is because few BOC trainees are MF staff. To identify the BOC population for this survey, we began by analyzing NEEC's BOC participant database for information that would help identify the MF staff. However, we discovered that the database does not differentiate MF and commercial staff. Out of 631 participants that received certification, 23% (or 143 participants) identified market sectors that may have included MF staff. Next, through a review of workplace addresses, Google Maps imagery, and company websites, we ultimately identified 83 participants with the potential to be MF staff.

Below, we describe the survey disposition categories illustrated in Table 5:

- **No response:** 55 individuals had valid contact information but did not answer after multiple attempts.
- **Invalid contact:** 31 individuals could not be reached either because of invalid contact information (bad e-mails or phone numbers) or we confirmed that they no longer worked at the company.
- **Refused:** 40 individuals were reached but refused the survey. Of these individuals, 20 were reached by telephone but refused the survey directly ("hard refusals") and 20 asked to be called back or have the email survey sent to them but subsequently did not answer the phone or complete the survey ("soft refusals").
- **Screened out:** 32 individuals responded but were disqualified during the survey either because they did not remember attending the training or they did not identify themselves as MF staff.
- **Mid-interview termination:** Three individuals began the survey but dropped out mid-way and did not return to complete the survey.
- **Disqualified in analysis:** Two completed the survey but were disqualified during the analysis phase because they were commercial property managers who initially, during the survey screening process, identified themselves as MF staff.

Table 5. Survey Dispositions

Disposition	BOC	BPI	Total
Available Sample	83	93	**176**
Valid Completes*	2	11	**13**
Could Not Reach			
No response	17	38	**55**
Invalid contact	14	17	**31**
Reached but Did Not Complete/Disqualified			
Refused	24	16	**40**
Screened out	24	8	**32**

[6] We state that a good share of contact information "appears" to no longer be valid but, in many cases, we were not able to distinguish between a simple lack of response and a given contact no longer working at the same company (i.e., the company they were employed by at the time of their training registration).

Disposition	BOC	BPI	Total
Mid-interview termination	0	3	**3**
Disqualified in analysis	2	0	**2**

*Does not include two respondents who completed the survey but who were "disqualified in analysis"

The 13 respondents represent 28 different properties.

Table 6. Summary of Survey Completes

Training Type	Valid Respondents	Number of Properties
BPI	11	26
BOC	2	2
Total	**13**	**28**

3.1.4 Participant In-depth Interviews

After fielding the survey, we identified 11 respondents who took O&M or EE retrofit actions post-training and reached out to them for in-depth interviews. The purpose of these in-depth interviews was to:

- Collect additional data on the actions respondents took and any additional facility details (e.g., hours of use, the size of the space that the measures affect);
- Confirm which multifamily programs the properties participated in, if applicable; and
- Learn more about training influence on actions taken, motivations for taking the training, and non-energy benefits of the training;

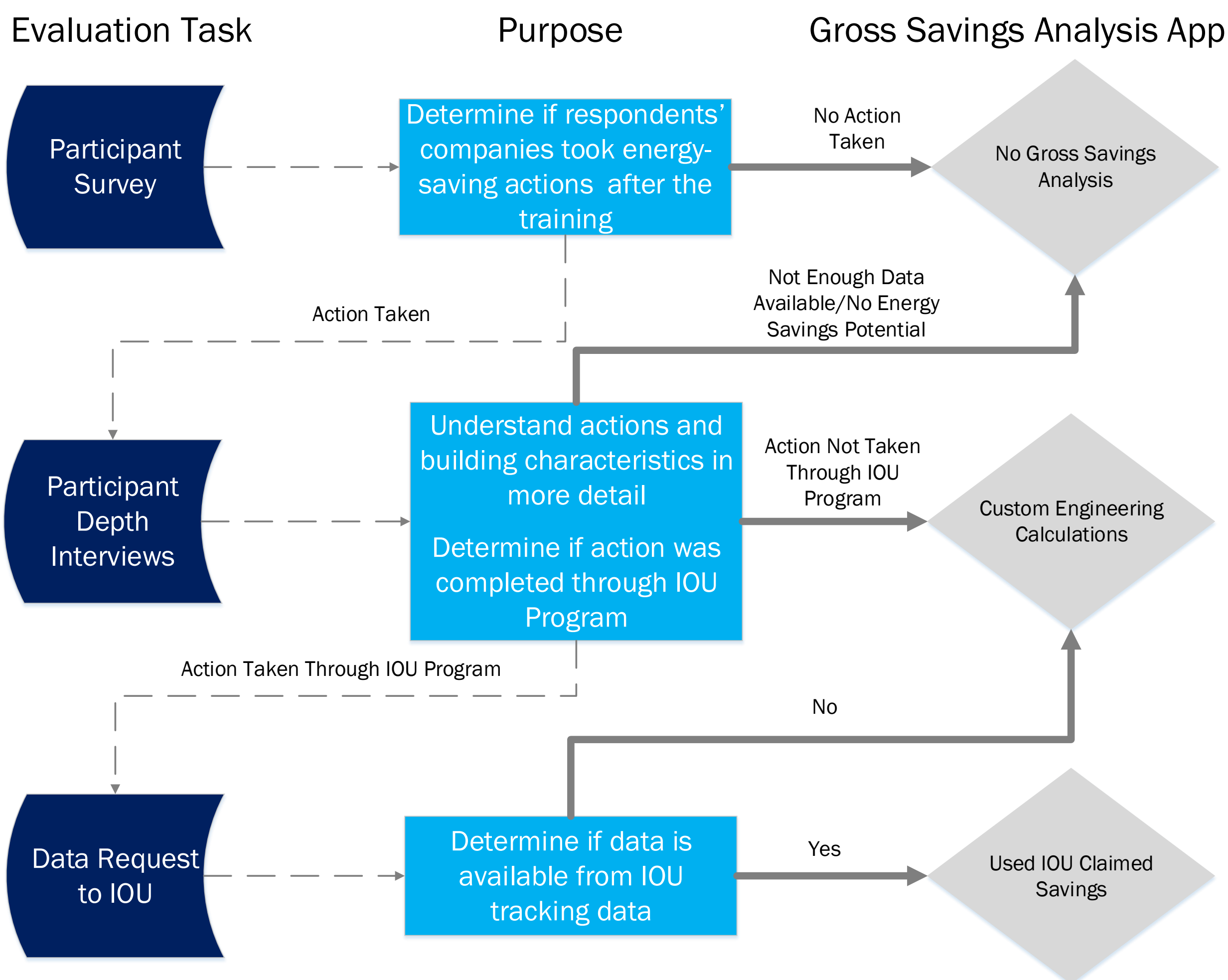
We used these data to inform our custom engineering analysis (see next section) and add additional depth to our case studies. For those who confirmed that their properties participated in an IOU program, we used these data to develop a data request to the IOUs for program participation data.

The evaluation team attempted to reach all 11 internet survey respondents who took action post-training. We attempted to contact respondents up to eight times, by phone and e-mail, and ultimately completed four in-depth interviews. While this represents more than a third of potential respondents, we note that we faced similar barriers to what we encountered during internet survey outreach. Of the seven who did not complete an interview, three were "hard refusals," three were "soft refusals," and one never responded.

3.1.5 Gross Savings Analysis

Gross impacts are the change in energy consumption (or demand) that results directly from actions taken by participants following the training, regardless of why they took those actions. Our gross savings analysis approach varied by participant depending on the actions they took after the training and whether they received a rebate for that action though an IOU program. Based on the in-depth interviews, the evaluation team learned that three of the four respondents had participated in IOU multifamily programs and some of the energy-saving actions they took after the training were incentivized through those programs. We requested participation data from the IOUs and applied IOU-claimed energy, demand, and gas savings to rebated actions. For actions that were not incentivized, we performed an engineering analysis to calculate custom gross savings. We leveraged data collected during in-depth interviews (i.e., quantity, hours of use, and heating/cooling characteristics) to inform our savings assumptions. Appendix E provides detailed gross savings calculation methods and sources. The evaluation team did not calculate gross savings for six upgrades reported by two respondents. We found that five actions did not have sufficient information to inform savings assumptions, and one action was still being implemented. Figure 3 below summarizes the process for determining our gross savings analysis approach.

Figure 3. Gross Savings Analysis Approach



We ultimately completed in-depth interviews with four respondents who took the BPI training, resulting in a case study for each one. As mentioned earlier, we did not attempt to generalize these findings to the population of participants due to limited sample size.

3.1.6 Net Savings and Channeling Analysis

Net impacts are defined as the impacts (i.e., change in consumption) that can be attributed to the training. Net impacts may be lower than total gross impacts if energy savings would have occurred in the absence of the training. We took the following steps to calculate what savings are attributable to the training and how much savings have already been claimed by the IOU multifamily programs.

- **Net Savings Analysis:** Using survey results, we develop free-ridership (FR) scores at the measure category (e.g., "lighting") level. FR scores are between 0 and 1 and represent the proportion of savings that would have occurred without the training. The net-to-gross ratio (NTGR) is the inverse of the FR score and represents the proportion of savings attributable to the training. The FR score included the following components:
  - The likelihood that a respondent's company would have taken action without the training;
  - The relative influence of the training compared to other factors in the company's decision to take action, such as reducing operating costs, tenant satisfaction, and rebates and tax credits;
  - The likelihood that the respondent's company would have taken the **same number** of actions without the training; and
  - The likelihood that the respondent's company would have taken action at the **same time** without the training.
- **Channeling analysis:** We compared survey respondents' reported actions to the rebated measures included in IOU multifamily program tracking databases. We present our findings in the case studies as a proportion of gross savings already claimed by the IOU programs.

Importantly, the NTGR already incorporates the influence of "other factors," including rebates from IOU programs. Thus, the NTGR is applied to total gross savings and net savings reflects the savings attributable to their participation in the training. We provide the NTGR algorithm in Appendix F.

3.2 Study Limitations

This study is subject to the following limitations:

- The results of this study cannot be generalized to the larger BOC/BPI participant population or to the broader market of MF staff, specifically:
  - Findings, conclusions, and recommendations in this study are largely based on a relatively small sample of BOC/BPI participants (n=13).
  - This study does not include training non-participants.
  - Impact estimates were developed using a case study approach and only includes four respondents.
- This study delves deeply into understanding what BOC/BPI trainings currently teach MF staff and what value those trainees are currently experiencing. As such, it provides the foundational information needed to facilitate a future market training gap analysis whereby we can compare MF staff's training needs against what BOC/BPI currently provides. This future study would then help determine if BOC/BPI trainings adequately fill the training gaps among the broader market of MF staff.

4. Key Findings

In this chapter, we present the result of our evaluation tasks. The findings are organized into four key topic areas: the energy savings potential of the training, the non-energy benefits of the training, O&M barriers and knowledge gaps among MF staff, and opportunities to enhance MF O&M and retrofits.

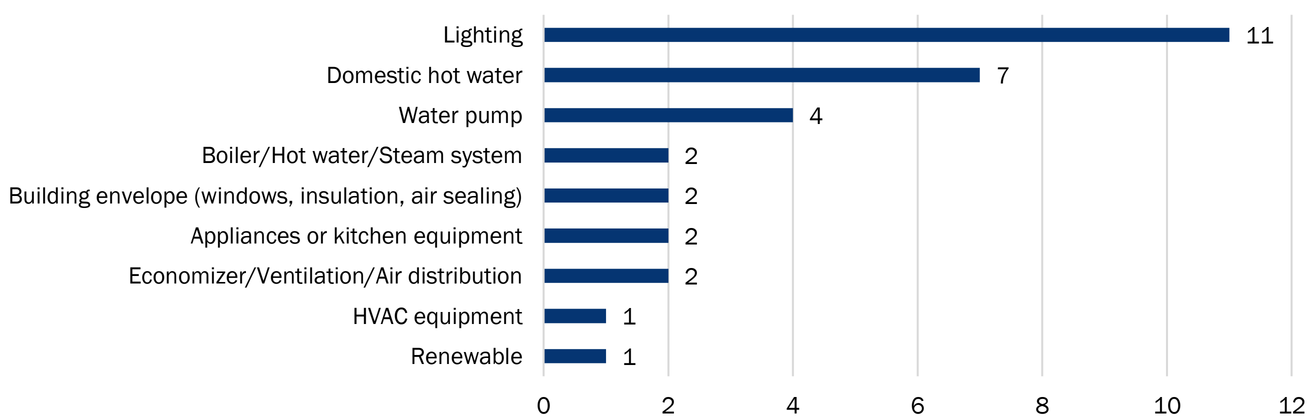
4.1 Energy Savings Potential of the Training

In this section, we first present survey results on actions taken by respondents and the influence of the training. Following that, we present four case studies of participants to showcase their stories and the energy savings at their properties attributable to the training.

4.1.1 Actions Taken Post-Training

Survey efforts identified 11 out of 13 training participants who took actions post-training. Among these 11, lighting and domestic hot water upgrades were most common. In the survey, we asked respondents if they made O&M or retrofit changes across nine possible building system categories. The 11 respondents took 32 unique actions. Of the 11 respondents who took action, all installed energy efficient lighting or controls and a little over half installed low flow devices. Many respondents (9 of 11) took multiple actions and many (9 of 11) took actions at multiple properties they oversee. Figure 4 presents actions taken by category.

Figure 4. Actions Taken by Building System Category (Multiple Response: n=11)



Note: Excludes two respondents who took no actions post-training

Table 7 provides additional detail on the number of properties upgraded and the actions taken. Notably, while the BPI/BOC trainings focus on O&M, the energy savings we found are exclusively coming from retrofit (i.e., equipment and control) upgrades versus O&M actions (e.g., changing control settings). However, as we highlight in our case studies in Section 4.1.4, many participants are applying what they learned to identify potential problems and upgrade opportunities and the training is taken in advance of planned upgrades to optimize their effectiveness.

Table 7. Actions Taken Detail (Multiple Response)

Action Category	Number of Respondents (n=13)	Number of Properties Upgraded (n=28)	Examples of Actions Taken
Lighting	11	19	• LEDs • Occupancy sensors/controls
Domestic hot water	7	11	• Low-flow devices (showerheads, faucet aerators)
Water pump	4	5	• Water pump replacement • Controls
Boiler/Hot water/Steam system	2	4	• Boiler replacement • Boiler devices and controls
Appliances or kitchen equipment	2	4	• Refrigerator replacement • Energy Star appliances
Economizer/Ventilation/Air distribution	2	4	• Duct cleaning • Fan-control devices
Building envelope (windows, insulation, air sealing)	2	2	• Window and door replacement • Caulking, weather stripping • Weatherization • Insulation
HVAC equipment	1	2	• Controls upgrades
Renewable	1	1	• Solar panels

4.1.2 Training Influence on Actions Taken

Overall, the training appears to have had a moderate influence on actions taken, as there is evidence that MF staff were already planning to take many actions. However, the training influenced respondents to take action earlier or to take more actions than they would have otherwise. Though we noted some qualitative trends, the sample sizes within each action category are too small to confidently make comparisons on training influence.

- **Action Likelihood Influence:** On a scale from 0 to 10, where 0 is "not at all likely" and 10 is "very likely" to take action without the training, respondents gave an average score of 7.6 across all actions (n=32). Only two actions of 32 had likelihood scores less than 4 out of 10 (Table 8). Further, later in the survey (Table 9) respondents indicate that three actions would not have happened at all without the training.

Table 8. Likelihood to Have Taken Action Without the Training (n=32)

Response	Likelihood to Take Action Without Training			
	0 to 3	4 to 6	7 to 10	Average
Number of Actions	2	10	20	7.6

- **Action Timing Influence:** About half of actions (18 of 32, or 56%) would have happened within six months absent the training. However, the remaining actions (14 of 32, or 44%) would have happened a year or more later, or perhaps not at all (three actions) (Table 9).

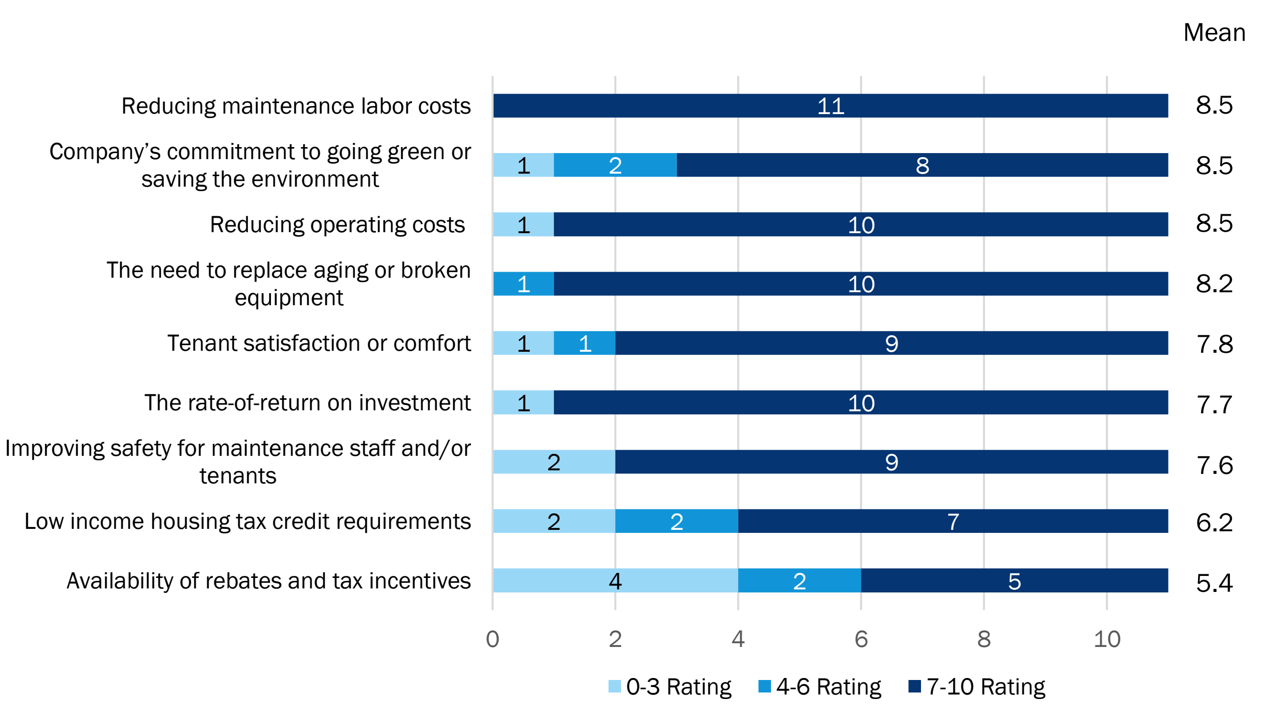
Table 9. Training Influence on Action Timing (n=32)

Response	Without the training, the company would have taken action...					
	At the same time	Within 6 months	6 months to 1 year later	1 to 2 years later	More than 2 years later	Would not have taken action at all
Number of Actions	11	0	7	6	5	3

- **Action Quantity Influence:** For 24 of the 32 actions (75%), respondents reported that they would have made “slightly fewer” changes without the training and six reported they would have made “significantly fewer” changes. The remaining two respondents indicated that the training did not influence the number of changes they made.

MF staff have a wide range of potential reasons for completing upgrades to their facilities, including reducing costs, improving company image, and keeping their tenants satisfied. Thus, it was important to measure the relative importance of the training in comparison to these “other” factors. As shown in Figure 5, reducing O&M costs and the company’s desire to “go green” were very important factors, as was the need to replace aging or broken equipment. Interestingly, rebates and tax incentives were the least influential.

Figure 5. Influence of Other Factors to Taking Action (n=11)



Scale from 0 to 10 where 0 is “very little influence” and 10 is “a great deal of influence”

However, the training still factored prominently in the mix of reasons to complete upgrades. After asking respondents to think about what other factors drove their decision to complete upgrades, we asked them to allocate ten influence points between these “other factors” and the training. On average, respondents allocated 5.6 influence points to the training (n=32) and 4.4 to other factors, indicating an almost even split overall between training influence and all other factors.

Table 10. Influence of Training on Actions

Response	Points Allocated to Training Influence			
	0 to 3	4 to 6	7 to 10	Average
Number of Actions	4	15	13	4.4

Net-to-Gross Summary

Considering all the factors above, we calculated NTGRs for each respondent and action category, as shown in Table 11. Ranges are provided for respondents who took action in multiple categories. As expected, given the data discussed above, we found that most respondents were moderately influenced by the training, though there were a few that were highly influenced by the training. Training influence typically did not vary between the types of actions for each respondent, as shown by the small ranges. A detailed description of the NTGR calculation methodology is provided in Appendix F.

Table 11. NTGR Summary

Respondent ID	Number of Actions Categories	Unweighted NTGR Range
High Training Influence		
R11	3	0.7 to 1.0
R3	6	0.7 to 0.9
R6	2	0.6 to 0.7
Moderate Training Influence		
R1	2	0.6
R4	2	0.5 to 0.6
R7	2	0.5 to 0.6
R9	3	0.5 to 0.6
R2	1	0.4
Low Training Influence		
R8	5	0.3 to 0.4
R10	5	0.2
R5	1	0.1

4.1.3 BPI Training Gross and Net Savings Summary

As detailed in Chapter 3, we completed in-depth interviews with four BPI respondents and no BOC respondents. Due to this small sample size, we conducted a case study approach and we did not attempt to extrapolate savings to the population of BPI respondents. As presented in Table 12 below, the BPI training does have the potential to provide some additional energy savings, though it is often not the main driver of energy savings actions (as shown by the lower NTGR in three cases). All four respondents were already planning retrofits to some extent, which limited the overall influence of the training. However, we found that the training generated some additional savings by enhancing these retrofits, either by informing decision on what technologies to choose or optimizing the implementation of the projects. We describe each case study in the next section.

Table 12. BPI Training Gross and Net Savings Summary

Case Study	Actions Summary	Gross Savings			Savings-Weighted NTGR	Net Savings		
		kWh	kW	Therms		kWh	kW	Therms
1	LEDs, fans-control devices, water pump controls, Low-flow devices	332,424	92.72	21,518	0.15	49,864	13.91	3,228
2	LEDs, motion sensors, water pumps, refrigerators, water heaters	156,844	7.75	2,274	0.38	58,856	2.08	782
3	Boilers, boiler controls, low-flow devices	0	0	1,703	0.67	0	0	1,135
4	LEDs	524	0.049	0	0.10	52	0.005	0

*We calculated a NTGR for each action category a respondent took (e.g., lighting, domestic hot water). The overall case study NTGR is weighted based on the savings from each category.

To put these savings into context, we compared the per-property savings from the four case studies to the ex-ante savings claimed by the 2013-2016 SCE/SCG Multifamily Whole Building Pilot and the 2013 PG&E Multifamily Whole Building Pilot. As shown in Table 13 below, the savings attributable to the BPI training represents anywhere from 0% to 104% of these programs' per property kWH savings. Importantly, this figure varied widely across the four case studies and additional research would be required to empirically confirm this finding. We also note that the impact estimation methods used for this study may not be comparable to those used for these comparison studies.

Table 13. Savings Comparison with SCE/SCG and PG&E Whole Building Pilots

Case Study	Number of Properties	Case Study Net kWh Savings Per Property	SCE/SCG Ex-Ante Savings Per Property (n=15)	% of SCE/SCG Savings	PG&E Ex-Ante Savings Per Property (n=7)	% of PG&E Savings
1	Three	16,621	56,648	29%	95,505	17%
2	One	58,856		104%		62%
3	One	0		0%		0%
4	One	1,135		2%		1%

Sources: SCE & SoCalGas Energy Upgrade California—Multifamily Pilot Process Evaluation. Opinion Dynamics/SBW (2016); Process Evaluation for PG&E's Energy Upgrade California Multifamily Pilot Program. Opinion Dynamics/SBW (2014).

4.1.4 Case Studies of Participants

In this section, we showcase the stories of four BPI trainees, whom we refer to as the "property managers" (PMs). Notably, three of the four respondents gave the evaluation team permission to identify their properties. In these case studies, we provide a summary of the properties they manage, the actions they took, and the energy savings they achieved. We also provide additional information on their motivations for taking the training, how the training influenced their decisions, and the non-energy benefits they experienced from the training.

Case Study One

The PM attended the BPI training in January 2015. At the time of the training the PM was the service manager for National Community Renaissance, a nonprofit affordable housing developer that develops, builds, and manages properties throughout North America. The PM was recently promoted within the company to Energy and Sustainability Coordinator, in charge of reducing the company's carbon footprint and overseeing all projects relating to energy reduction and water saving measures. The PM maintains 25 properties, running day-to-day operations overseeing all capital improvement projects, and directs all maintenance technicians. The PM reported a very high level of influence (10 out of 10, where 10 is "very influential) on decisions made at the National Community Renaissance properties.

The evaluation team asked the PM about the energy upgrades made at the three largest properties the PM oversees. Table 14 provides a summary of these properties, located in San Bernardino County.

Table 14. Case Study One – Property Characteristics

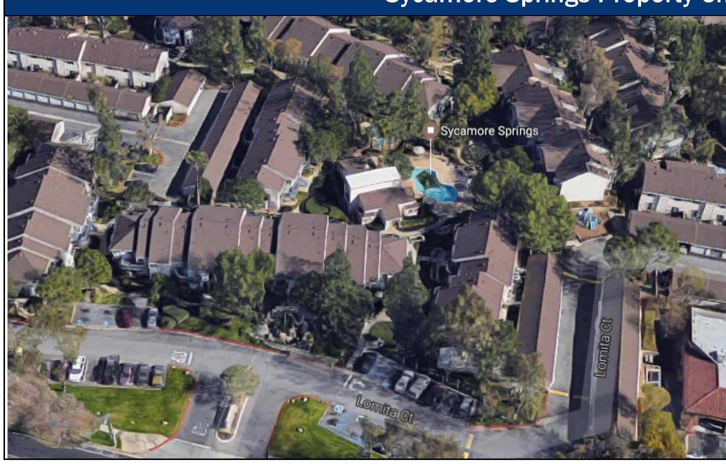
Mountainside Property Characteristics

Number of Units	384
Number of Residents	500-999
Square Footage	Over 1,000,000
Ownership Structure	Each property is unique; some are privately owned some have investors
% of Low Income Units	76-99%
Annual Electricity and Gas Cost	Unknown

Rancho Verde Property Characteristics

Number of Units	248
Number of Residents	500-999
Square Footage	Over 1,000,000
Ownership Structure	Each property is unique; some are privately owned some have investors
% of Low Income Units	51-75%
Annual Electricity and Gas Cost	Unknown

Sycamore Springs Property Characteristics



Number of Units	240
Number of Residents	500-99
Square Footage	Over 1,000,000
Ownership Structure	Each property is unique; some are privately owned some have investors
% of Low Income Units	51-75%
Annual Electricity and Gas Cost	Unknown

The PM was required by the company to take the BPI training, as the company was planning to bid on several new properties and thought having a BPI-certified property manager would be a competitive edge. The PM was also personally interested in learning more about building operations and maintenance. On average, the PM reported slight knowledge gain across various building systems after the training (an average knowledge increase of 1.4 points on a 0 to 4 scale). The PM mentioned that the training was helpful in spotting problems regarding the building envelope day-to-day.

"The knowledge that you receive on the building envelope was huge for me. Being able to detect any kind of wood rot, break in the stucco, window trim. And they actually took us to a property when we were done with the training. We got to go through and look at a property that was nearby the training facility where we actually got to walk around and point out stuff and deficiencies and any break in the building envelope itself."

The training also helped the PM gain a better understanding of the EE technologies available and O&M techniques. In particular, the PM mentioned gaining knowledge regarding what type of lighting is suitable for specific types of locations and purposes.

"Before taking the training I didn't really know too much about LEDs. I didn't even know what LED stood for. After I took the training I think I just had a better understanding about lighting, where to put the correct lighting, and how high up lighting needs to be…[The training] definitely made me more aware of locations, type of wattage and things like that."

The PM also mentioned a number of other non-energy benefits that resulted from the training, including a promotion and being more aware of health and safety issues.

As shown in Table 15, after the training, the PM oversaw seven upgrades across four system categories, though most were water-related. These upgrades were a mix of equipment replacements and controls. In total, the upgrades resulted in 332,324 kWh, 92.72 kW, and 21,518 therms in gross savings. The majority of the electric savings came from lighting upgrades and most gas savings came from water pump controls. Notably, the PM also reported that the company installed new weather stripping on doors, but the evaluation team did not have sufficient data to calculate savings from this action.

Table 15. Case Study One – Actions Taken and Gross Savings

Category	Action	Mountainside	Rancho Verde	Sycamore Springs	Gross Savings		
					kWh	kW	Therms
Lighting	Installed LED A-lamps and fixtures	✓	✓	✓	210,074	8.83	0
Economizer/ Ventilation/ Air distribution	Installed fan-control devices	✓	✓	✓	78,105	77.75	0
Water Pump	Installed variable high-speed pool pumps		✓		27,498	4.28	0
Water Pump	Installed demand control recirculation pump	✓	✓		16,746	1.85	13,527
Domestic Hot Water	Installed low flow showerheads	✓	✓		0	0.00	4,991
Domestic Hot Water	Installed low flow aerators	✓	✓		0	0.00	2,993
Domestic Hot Water	Installed low flow devices (other)			✓	0	0.00	7
				Total	**332,424**	**92.72**	**21,518**

While the PM found the training to be valuable, the training was not a key driver behind the company's decision to make the energy efficiency upgrades. According to the PM, the California drought triggered the company's water conservation efforts, as the City was preparing to levy fines for excessive water use (which drove the focus on water-related measures). Thus, the company began seeking rebates and tax incentives opportunities available to them through SoCal Gas (SCG), Southern California Edison (SCE), and various third parties.

The components of the NTGR calculation for this case study are in Table 16 below. Notably, while the company was highly likely to complete the upgrades without the training, the PM gave somewhat conflicting feedback on the relative influence of the training compared to other factors (the PM said the training was relatively more important). As we mentioned above, the PM stated there was value in the training in terms of knowing what technologies were available and knowing how to properly install them (e.g., lighting placement, controls settings). Thus, some additional savings may have been attributable to the training due to efficiencies gained from improved implementation.

Table 16. Case Study One – Training Influence Summary

Component	Response*
Likelihood to take action without the training (0-10, where 10 = "very likely")	10
Relative influence of the training compared to other factors (total of 10 points)	Training—6 points Other factors—4 points
Training influence on timing of action	The training did not change the timing of the action
Training influence on quantity of actions	Would have made the same number changes
NTGR	0.15

*The PM's responses did not vary by action category.

Based on these responses, we determined that a small portion (15%) the savings was attributable to the training. As Table 17 shows, applying this NTGR resulted in net savings of 49,864 kWh, 13.91 kW, and 3,228 therms. All of the actions taken by the company were incentivized or companies were provided free measures through SCE and SCG multifamily programs. These programs included the Energy Savings Assistance (ESA), Multifamily Energy Efficiency Rebate (MFEER), On-Demand Efficiency, and Multifamily Home Tune-up programs. Thus, 100% of savings is already claimed by IOU programs.

Table 17. Case Study One – Net Savings

Action	Gross Savings			NTGR	Net Savings			Channeled to Another Program
	kWh	kW	Therms		kWh	kW	Therms	
Installed LED A-lamps and fixtures	210,074	8.83	0	0.15	31,511	1	0	Yes
Installed fan controlled devices	78,105	77.75	0		11,716	12	0	Yes
Installed variable high speed pool pumps	27,498	4.28	0		4,125	1	0	Yes

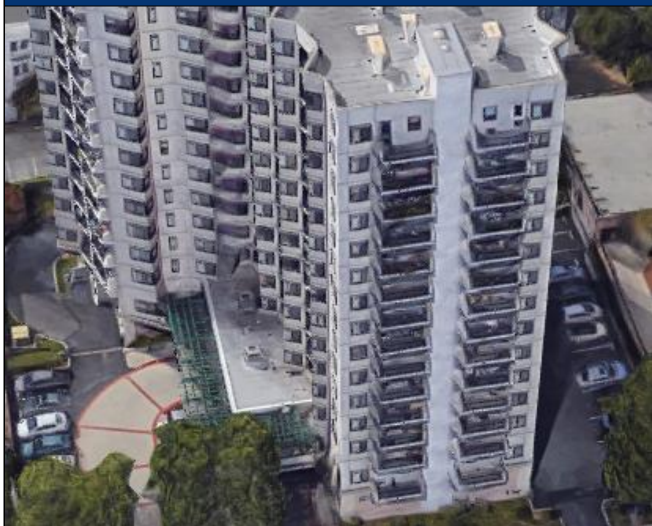
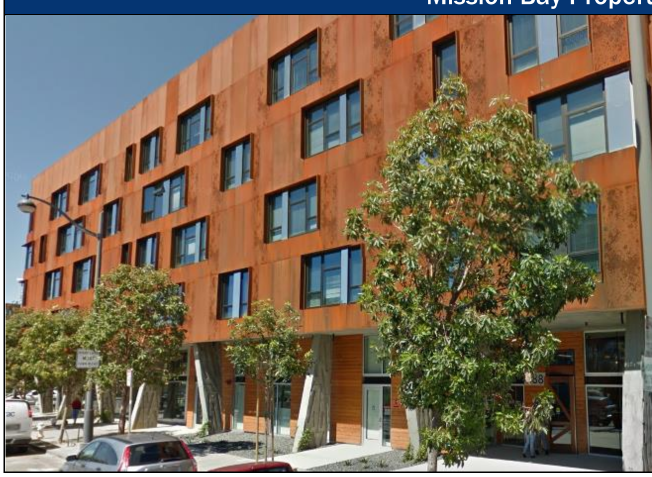
Action	Gross Savings			NTGR	Net Savings			Channeled to Another Program
	kWh	kW	Therms		kWh	kW	Therms	
Installed demand control recirculation pump	16,746	1.85	13,527		2,512	0	2,029	Yes
Installed low flow showerheads	0	0.00	4,991		0	0	749	Yes
Installed low flow aerators	0	0.00	2,993		0	0	449	Yes
Installed low flow devices	0	0.00	7		0	0	1	Yes
Total	**332,424**	**92.72**	**21,518**	**0.15**	**49,864**	**13.91**	**3,228**	**N/A**

Case Study Two

The PM attended the BPI training in May 2015 and is the Maintenance Supervisor at Noble Apartments, though the PM also supports several other multifamily properties in the San Francisco Bay Area. The PM reported a high level of influence on decisions made at Noble Tower Apartments (9 out of 10, where 10 is "very influential"), and moderate influence at Moher 1 and Mission Bay apartments (7 and 5 out of 10, respectively).

We asked about the energy upgrades made at the three largest properties the PM oversees and supports. Table 18 below provides a summary of these properties.

Table 18. Case Study Two – Property Characteristics

Noble Tower Apartments Property Characteristics		
	Number of Units	200
	Number of Residents	100-249
	Square Footage	Under 25,000
	Ownership Structure	Owns
	% of Low Income Units	1-25%
	Annual Electricity and Gas Cost	Unknown
Mohr 1 Apartments Property Characteristics		
	Number of Units	185
	Number of Residents	250-499
	Square Footage	Under 25,000
	Ownership Structure	Owns
	% of Low Income Units	25-50%
	Annual Electricity and Gas Cost	Unknown
Mission Bay Property Characteristics		
	Number of Units	200
	Number of Residents	Unknown
	Square Footage	Under 25,000
	Ownership Structure	Owns
	% of Low Income Units	None
	Annual Electricity and Gas Cost	Unknown

The PM was required to take the BPI training by the City of Berkeley Housing Authority. According to the PM, at least one employee at the company was required to be BPI-certified. The company was also interested in earning low-income tax credits available to companies who had a staff member take the BPI training. On average, the PM reported slight knowledge-gain across various building systems after the training (an average knowledge increase of 1.1 points on a 0 to 4 scale), particularly regarding the building envelope.

"The BPI training aided me to be able to think about the whole building as a system."

The PM also mentioned a number of other non-energy benefits that resulted from the training, including earning a promotion and increased knowledge in health and safety issues. For instance, at one of the properties, the training was essential in helping identify gas leaks.

"The training I received was very helpful for me and it opened up a new direction at my present company."

As shown in Table 19, after the training, the PM oversaw six upgrades in Noble Tower tenant units that resulted in 156,844 kWh, 9.30 kW, and 2,274 therms in gross savings. Lighting represented the most (89%) of electric savings, including lamp replacement and new controls, though new water heaters provided some gas savings as well. The evaluation team was not able to calculate gross savings for appliance and building envelope upgrades completed at the other two properties, Mohr 1 and Mission Bay, due to insufficient data.

Table 19. Case Study Two – Actions Taken and Gross Savings

Category	Action	Noble Tower	Gross Savings		
			kWh	kW	Therms
Lighting	Replaced 40W – 75W equivalent CFLs, halogens, and incandescent lamps with LEDs	✓	83,027	1.02	0
Lighting	Installed CFL lamps and fixtures	✓	31,355	3.72	0
Lighting	Installed motion sensors	✓	25,185	3.67	0
Water Pump	Installed energy efficient water pumps	✓	12,061	0.00	0
Appliances or kitchen equipment	Installed energy efficient refrigerators	✓	5,217	0.89	0
Domestic Hot Water	Installed energy efficient gas water heaters	✓	0	0.00	2,274
		Total	**156,844**	**9.30**	**2,274**

The training was not very influential in the decision to make energy upgrades. According to the PM, many of the upgrades were already being planned prior to attending the training. However, the PM found the training especially helpful in determining how to implement the upgrades. Further, the PM reported that AEA (the training implementer) was critical in identifying rebates to pay for the upgrades, which may have increased the number of measures the company was able to implement (the PM mentioned that the training "slightly increased" the number of upgrades they completed). The components of the NTGR calculation for this case study are in Table 20 below.

"Overall, the training made the goals that my company strives to reach easier to obtain."

Table 20. Case Study Two – Training Influence Summary

Component	Lighting	Appliances or kitchen equipment	Boilers	Water Pump
Likelihood to take action without the training (0-10, where 10 = "very likely")	8 (all actions)			

Component	Lighting	Appliances or kitchen equipment	Boilers	Water Pump
Relative influence of the training compared to other factors (total of 10 points)	Training—5 points Other factors—5 points	Training—0 points Other factors—10 points	Training—3 points Other factors—7 points	Training—3 points Other factors—7 points
Training influence on timing of action	The training did not change the timing of the changes			
Training influence on quantity of actions	Would have made slightly fewer changes			
NTGR	0.38	0.29	0.34	0.34

Based on these responses, we determined that about a third (38%) of the gross savings was attributable to the training. As shown in Table 21 below, applying this NTGR resulted in net savings of 58,856 kWh, 3.46 kWs, and 782 therms.

Table 21. Case Study Two – Net Savings

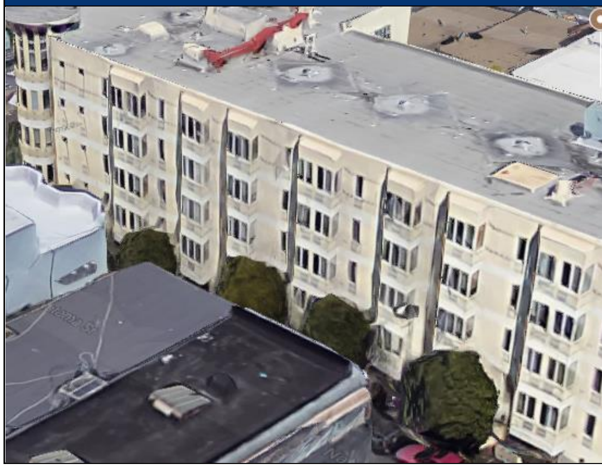
Action	Gross Savings			NTGR	Net Savings			Channeled to Another Program
	kWh	kW	Therms		kWh	kW	Therms	
Replaced 40W – 75W equivalent CFLs, halogens, and incandescent lamps with LEDs	83,027	1.02	0	0.38	31,654	0.39	0	No
Installed CFL lamps and fixtures	31,355	3.72	0	0.38	11,954	1.42	0	Yes
Installed motion sensors	25,185	3.67	0	0.38	9,602	1.40	0	No
Installed energy efficient gas water heaters	0	0.00	2,274	0.34	0	0.00	782	No
Installed energy efficient water pumps	12,061	0.00	0	0.34	4,146	0.00	0	No
Installed energy efficient refrigerators	5,217	0.89	0	0.29	1,500	0.26	0	Yes
Total	**156,844**	**9.30**	**2,274**	**0.38**	**58,856**	**3.46**	**782**	**N/A**

The company received assistance for two of the upgrades through PG&E's ESA program. The savings already claimed by the ESA program represent 23% of gross energy savings and half (50%) of gross demand savings, but none of the gas savings.

Case Study Three

The PM attended the BPI training in May 2015 and is employed as a Site Director at Canon Kip Apartments in the San Francisco Bay Area. The PM reported a high level of influence on decisions made at the company (8 out of 10, where 10 is "very influential"). Table 22 below provides a summary of the property.

Table 22. Case Study Three – Property Characteristics

Canon Kip Property Characteristics		
	Number of Units	104
	Number of Residents	50-99
	Square Footage	Don't Know
	Ownership Structure	Contracted property management company
	% of Low Income Units	100%
	Annual Electricity and Gas Cost	$40,000

The company required the PM to take the BPI training as one of the qualifying criteria for a low-income tax credit. The PM said the training clarified the different EE technologies available and methods to control energy usage at the property. On average, the PM reported slight knowledge-gain across various building systems after the training (an average knowledge increase of 1.4 points on a 0 to 4 scale), but experienced more knowledge-gain in the areas of building envelope (three-point increase) and HVAC (two-point increase).

"My personal knowledge itself [has increased]. When a plumbing job is happening, when we are having issues with our heating system and/or our ventilation system, I can look at what [the tenants] have and help troubleshoot and offer suggestions of improvement to help them save energy."

The PM also mentioned several non-energy benefits that resulted from the training, including a promotion to a higher position with increased pay and changes to O&M practices. The PM said the training was helpful in learning how to go about maintaining equipment.

"The training heightened my senses in terms of me being more aware of the functions of a building. I find myself, everywhere I go, looking at the pipes, looking at ducts, seals, windows and stuff like that. We have a preventative maintenance schedule that we have in-house. Not only with just the vendor. We check if there are any vacuum leaks anywhere, any ducts, seals, so we will know ahead of time before we contact a vendor what we need to have done."

As shown in Table 23, after the training, the PM oversaw one boiler and two hot water upgrades at Canon Kip that resulted in 1,703 gross therm savings. While the PM also reported four additional upgrades[7], we did not calculate gross savings due to a lack of data to inform savings calculations.

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[7] We could not reliably estimate gross energy savings for three of the four upgrades. They include hot water storage tank replacement, motors installation, and water pump installation. The hot water storage tank replacement involved replacing one 600-gallon hot water storage tank with three 200-gallon tanks. We were unable to determine the insulation levels of the baseline and new tanks and therefore could not accurately determine savings. Furthermore, even if insulation levels increased with the new tank, surface area of the tanks also increased with the project which may have offset any potential savings. The PM also reported upgrading motors on air handlers to provide a "stronger" circulation of air. Since no other information was provided (model number, horsepower, efficiency), we could not estimate savings (or a penalty) for this project. Finally, the water pump installation is a replace-on-burnout project with the same equipment which did not result in energy savings. The final upgrade is a lighting retrofit that the PM confirmed has yet to occur.

Table 23. Case Study Three – Actions Taken and Gross Savings

Category	Action	Gross Savings		
		kWh	kW	Therms
Boiler	Boiler replacement with new controls	0	0.00	1,635
Domestic Hot Water	Installed low flow showerheads	0	0.00	42
Domestic Hot Water	Installed low flow aerators	0	0.00	26
	Total	0	0	1,703

In contrast to the other three case studies, the training was a key driver of the company's decision to make upgrades. According to the PM, the training helped justify the upgrades to the company and the training influenced the company to seek out rebates for upgrades and vendors that help monitor energy usage (e.g., energy service companies, or ESCOs).

"[The training] gave me the recommendations for the actions, based on what we had present in the building. [I was] able to present this is what I learned and from what I learned this is what I noticed about our building, and these are the recommended changes that I am making. I am bringing [the recommendations] forth and saying this is what we need to do based on what I learned in the training."

The components of the NTGR calculation for this case study are in Table 24 below, though we note that many actions that the company took are excluded from this calculation (see text above Table 23). Notably, the training was especially influential in increasing the scale of the upgrades made and the decision to complete domestic hot water upgrades.

Table 24. Case Study Three– Training Influence Summary

Component	Boiler	Domestic Hot Water
Likelihood to take action without the training (0-10, where 10 = "very likely")	10	5
Relative influence of the training compared to other factors (total of 10 points)	Training—8 points Other factors—2 points	
Training influence on timing of action	Would have made changes 6 months to 1 year later	Would have made changes 1 to 2 years later
Training influence on quantity of actions	Company would have made significantly fewer changes.	
NTGR	0.66	0.76

Based on these responses, we determined that only about two-thirds of savings was attributable to the training. As shown in Table 25 below, applying this NTGR resulted in net savings of 1,135 therms.

Table 25. Case Study Three – Net Savings

Category	Action	Gross Savings			NTGR	Net Savings			Channeled to Another Program
		kWh	kW	Therms		kWh	kW	Therms	
Boiler	Boiler replacement with new controls	0	0.00	1,635	0.66	0	0	1,083	No
Domestic Hot Water	Installed low flow showerheads	0	0.00	42	0.76	0	0	32	Yes
Domestic Hot Water	Installed low flow aerators	0	0.00	26	0.76	0	0	20	Yes

Category	Action	Gross Savings			NTGR	Net Savings			Channeled to Another Program
		kWh	kW	Therms		kWh	kW	Therms	
	Total	0	0	1,703	0.67	0	0	1,135	N/A

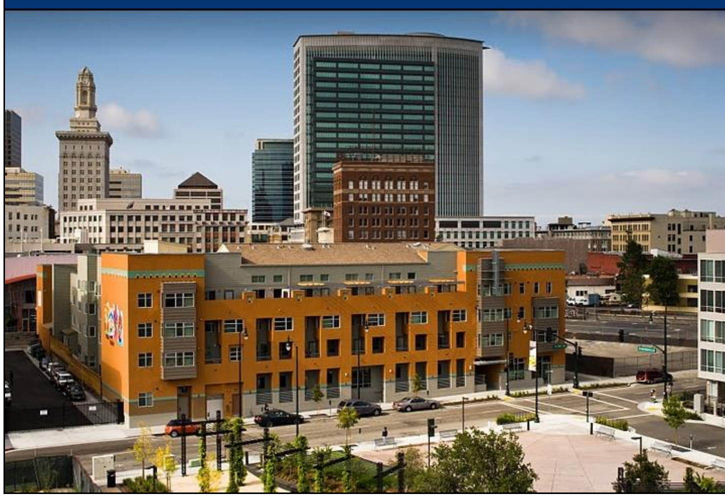
The company received assistance from the PG&E ESA program for the low-flow measures. Thus, that program already claims 4% of Therms savings.

Case Study Four

The PM at "ABC Apartments"[8] attended the BPI training in Spring 2013. This PM oversees a large[9] property in the San Francisco Bay Area and is an influential decision maker at the property (PM self-reported influence on decision-making was as an 8 out of 10, where 10 is "very influential). Table 26 below provides a summary of the property.

Table 26. Case Study Four – Property Characteristics

ABC Apartments Property Characteristics



Number of Units	80
Number of Residents	250-499
Square Footage	250,001 - 750,000
Ownership Structure	Owns, Partnership
% of Low Income Units	26-50%
Annual Electricity and Gas Cost	Unknown

The PM's employer (the building owner) required the BPI training in an effort to "go green" at the property. The PM said that the training was too technical, but did gain a basic understanding of EE technologies and O&M techniques. On average, self-reported knowledge of various building systems increased by two points (on a 0 to 4 scale), and lighting knowledge by three points.

"I remember learning about how heating works, systems and AC. And just little things you should do to make sure the equipment is running safely."

The PM also mentioned a number of non-energy benefits that resulted from the training, including improving safety for maintenance staff and tenants by identifying hazards and educating the tenants on how to be become more "green".

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[8] This respondent requested that their identity and company be kept anonymous.

[9] A large multifamily property is defined as 50 or more units. Source: American Community Survey Three Year Estimates 2009-2011 (U.S. Census Bureau 2011)

As shown in Table 27, after the training, the PM oversaw a LED retrofit in tenant units that resulted in 524 kWh and 0.049 kW gross savings.

Table 27. Case Study Four– Actions Taken and Gross Savings

Category	Action	Gross Savings		
		kWh	kW	Therms
Lighting	Replaced 40W – 55W fluorescents with LEDs	524	0.049	0.00

The training was not a key driver of the decision to make the LED retrofit. According to the PM, the ballasts in the building were too old to find replacement parts, so they needed to perform an upgrade. A friend of the PM mentioned LEDs, so the PM opted to install LEDs based on the cheapest ones available. The PM mentioned that the training was helpful in learning more about LED technology, but did not drive the initial decision to upgrade. The components of the NTGR calculation for ABC Apartments' are included in Table 28 below.

Table 28. Case Study Four – Training Influence Summary

Component	Response
Likelihood to take action without the training (0-10, where 10 = "very likely")	9
Relative influence of the training compared to other factors (total of 10 points)	Training—3 points Other factors—7 points
Training influence on timing of action	The training did not change the timing of the action
Training influence on quantity of actions	Would have made the same number changes
NTGR	0.10

As such, we determined that only a small portion (10%) of the savings was attributable to the training. As shown in Table 29 below, applying this NTGR resulted in net savings of 52.32 kWh and 0.005 kW.

Table 29. Case Study Four– Net Savings

Action	Gross Savings			NTGR	Net Savings			Channeled to Another Program
	kWh	kW	Therms		kWh	kW	Therms	
Replaced 40W – 55W fluorescents with LEDs	524	0.049	0.00	0.10	52	0.005	0.00	No

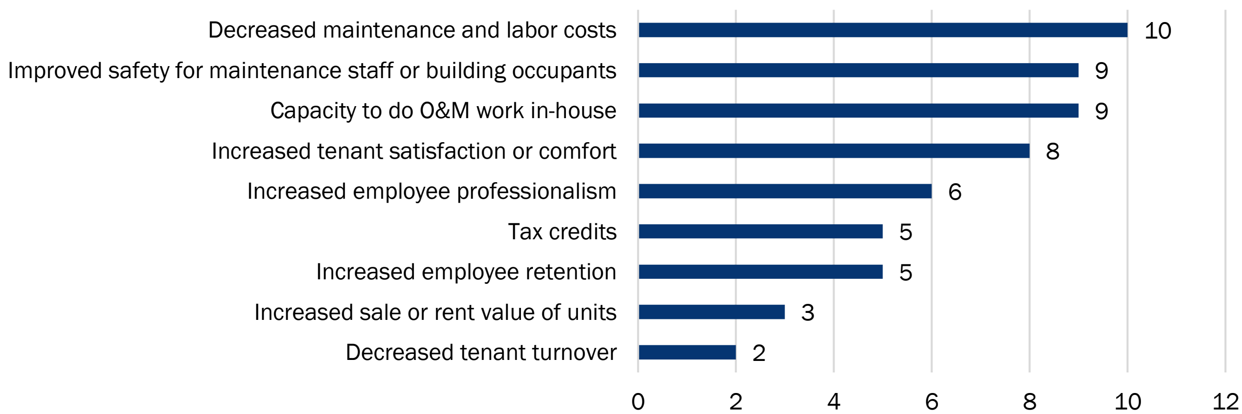
The company did not complete these retrofits through another program, thus these savings are not being captured through the existing IOU resource programs.

4.2 Non-Energy Outcomes of the BOC/BPI Training

As we have highlighted in the case studies, the value of the training goes far beyond energy savings. In this section, we provide additional findings regarding non-energy outcomes from training based on data from all 13 survey respondents.

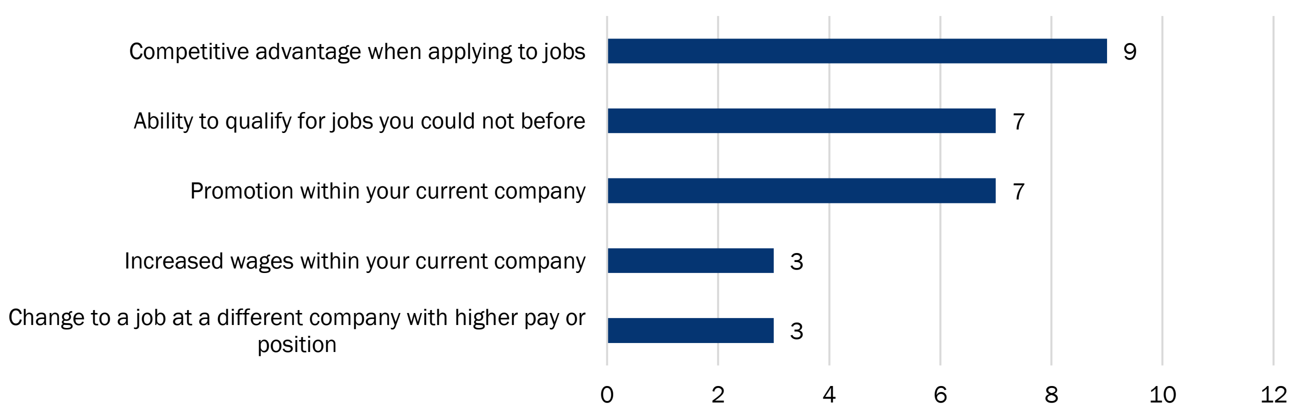
Overall, many respondents initially took the training because it was a requirement of their employer (7 of 13). In the case studies, companies were motivated by state and local requirements (e.g., city ordinances and state levies for excessive water use) as well as low-income tax credits and, in one case, the improved company image by going "green". As shown in Figure 6, survey respondents mentioned a wide variety of financial and non-financial (e.g., health and safety) benefits from the training.

Figure 6. Company Benefits to BOC/BPI Training (Multiple Response: n=13)



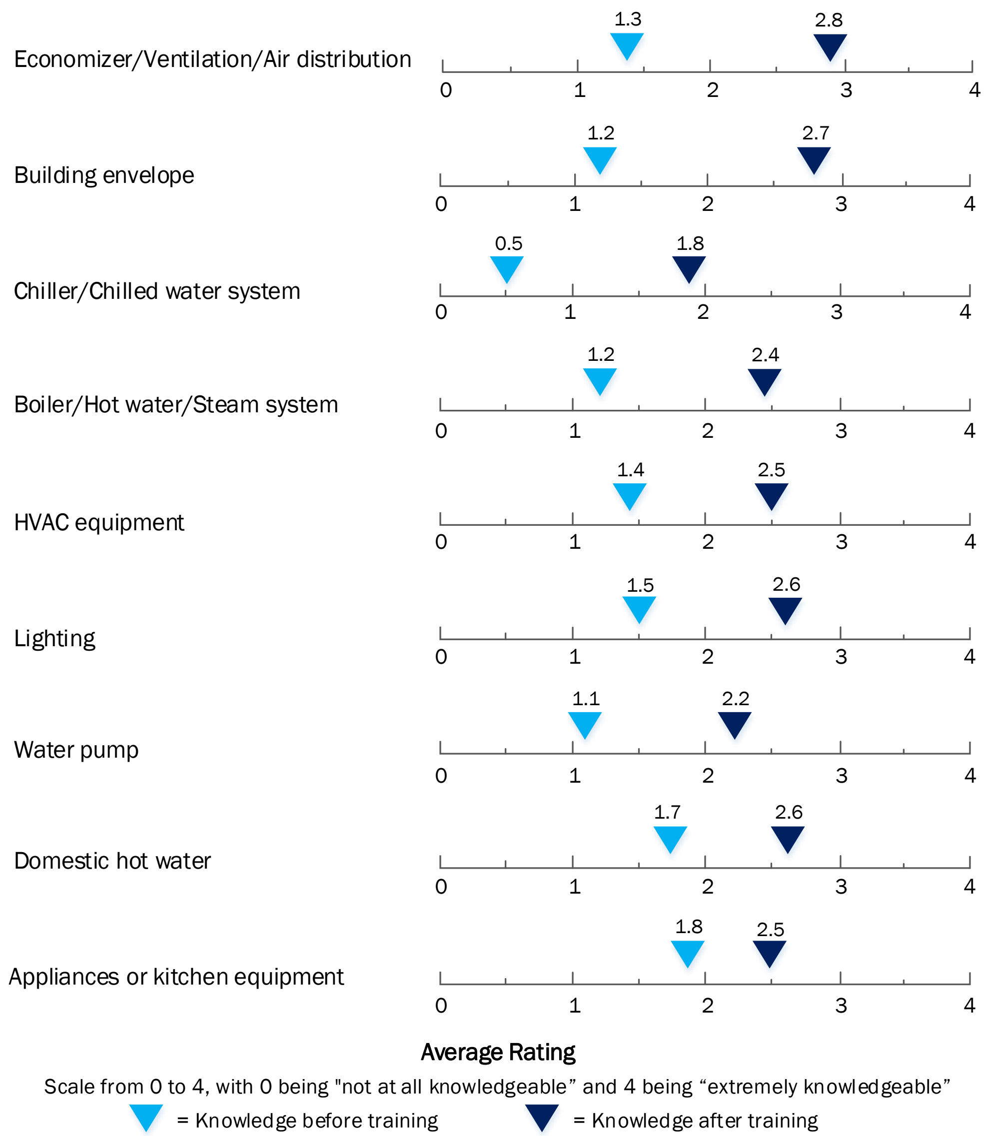
Beyond the company benefits, Figure 7 illustrates that the training appeared to be personally beneficial to the careers of many respondents, including promotions and increases in pay. As one of our case study respondents mentioned, after the training the respondent received a promotion from service manager to an energy management-specific role, Energy and Sustainability Coordinator.

Figure 7. Personal Benefits to BOC/BPI Training (Multiple Response: n=13)



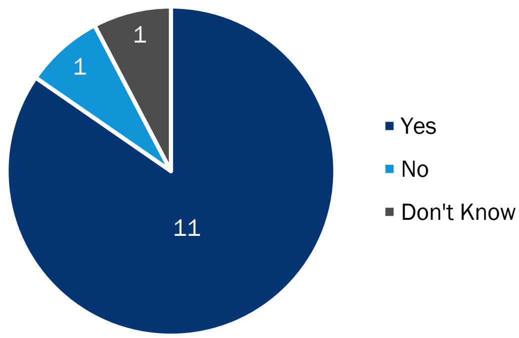
While our energy savings analysis in the previous section focused on actual upgrades, the training also resulted in an increase of respondents' capacity to conduct O&M in-house (mentioned by 9 of 13 respondents) and their general knowledge of building systems. As case study respondents mentioned, the training was valuable to understand EE technologies, analyze building systems, detect issues, and improve maintenance practices. In the survey, respondents were asked to rate their knowledge of various system categories before and after the training. As shown in Figure 8, respondents typically rated their knowledge as below average (between 1 and 2 on a scale from 0 to 4) before the training and then rated themselves as above average (between 2 and 3 on a scale from 0 to 4) after the training. The topics where respondents gained the most knowledge after the training were areas concerning economizer/ventilation/air distribution, building envelope, and chiller/chilled water systems.

Figure 8. Knowledge Gained by the BOC/BPI Training (n=13)



Further, most respondents shared the knowledge they gained from the training with staff at their company involved in O&M, as seen in Figure 9. Notably, over half of respondents manage five or more employees. This suggests that sending at least one management/supervisor personnel to the training would serve as a valuable knowledge dissemination tactic without any additional cost to the employer.

Figure 9. Passed Knowledge from the BOC/BPI Training Down to Staff (n=13)



4.3 O&M Training Barriers and Key Knowledge Gaps at Multifamily Properties

In this section, we present findings on barriers to O&M training, as reported by survey respondents, and key O&M knowledge gaps observed by the Whole Building Multifamily program implementation staff we interviewed. Following this section, we discuss opportunities to overcome these barriers to enhance O&M and EE retrofits.

The majority of respondents noted costs as the top barrier they face to getting O&M training (11 of 13), though most respondents' exam and course fees were covered by their employer (12 of 13). The next most common barrier was the time required to take the training (7 of 13). As one respondent indicated:

"Right now, I don't have the money to pay for it, or get the days off work."

In our interviews with PA multifamily program implementers, we asked them to think about building systems with the highest training needs among MF staff (they ranked them as "high", "medium", or "low"). Table 30 ranks each system according to what PA multifamily program implementers believe are the highest training needs. The systems where all implementers observed a high need for training included water pumps, domestic hot water, and boiler/hot water/steam systems. Implementers mentioned that these systems function together and that multifamily O&M staff often find them complex and intimidating. This is consistent with the internet survey findings, where we observed a lower baseline knowledge, and larger increase in knowledge from the training, for water pumps, boilers, and chiller systems, compared to other systems. Notably, multifamily program implementers did not identify chillers/chilled water systems as a major priority, as these types of equipment are not common in California multifamily properties.

Lighting and appliances/kitchen equipment were areas where implementers least often (one of five for each) reported a "high" need, as multifamily property managers generally have a basic understanding of the equipment and systems. However, four of five implementers reported a moderate need for training on lighting controls and combustion safety for kitchen appliances. This is also consistent with survey respondents self-reported knowledge of these systems before and after the training.

Table 30. Training Need by System

System	Number of Implementers that Observe a High Need	O&M Topic Areas
Water pumps	5/5	• Settings & Controls (4/5) • Repairs and Preventative Maintenance (2/5) • Equipment Systems & Functions (2/5)
Domestic hot water	5/5	• Repairs and Preventative Maintenance (4/5) • Equipment Systems & Functions (2/5) • Settings & Controls (2/5)
Boiler/hot water/steam system	4/5	• Equipment Systems & Functions (4/5) • Repairs and Preventative Maintenance (2/5) • Settings & Controls (1/5)
HVAC equipment	3/5	• Repairs and Preventative Maintenance (3/5) • Health and Safety Testing (2/5) • Settings & Controls (1/5)
Chiller/chilled water system	3/5	• Equipment Systems & Functions (3/5) • Repairs and Preventative Maintenance (1/5)
Building envelope (windows, insulation, air sealing)	3/5	• Repairs and Preventative Maintenance (2/5) • Equipment Systems & Functions (2/5)
Economizers/ventilation/air distribution	2/5	• Repairs and Preventative Maintenance (2/5) • Equipment Systems & Functions (1/5)
Appliances or kitchen equipment	1/5	• Health and Safety Testing (1/5)
Lighting	1/5	• Settings & Controls (1/5)

4.4 Opportunities to Enhance O&M and EE Retrofits at Multifamily Properties

Our case studies and analysis of survey responses show that the curriculum provided by the BOC/BPI trainings have the potential to enhance EE retrofits as well as fill many of the high-priority O&M knowledge gaps observed by program implementers. As we detail below, the current suite of Whole Building Multifamily programs does not have a formal focus on O&M. Thus, there appears to be an opportunity to enhance EE retrofits, and subsequent O&M practices to maintain those upgrades, by findings ways to pair multifamily program offerings with BOC/BPI O&M training.

In our discussions with Whole Building multifamily program implementers, we found that O&M training is not a formal part of their program, as the programs do not incentivize O&M practices. However, all PA implementation staff we interviewed mentioned that informal, "over-the-shoulder" O&M advice is commonly provided during on-site assessments. This advice is provided on an ad hoc basis depending on the O&M staff's interest in the assessment, the rater/implementer's observations on-site, and the new measures that the facility is considering. Common themes across all programs included discussions of how equipment and systems work, routine preventative maintenance (such as cleaning, tune-ups, or changing filters), and optimal equipment controls and settings.

In this sense, the topics discussed during program on-site assessment naturally align with the BOC/BPI training curriculum. However, what distinguishes these offerings is the level at which information is delivered. The BOC/BPI training provides a much broader overview of building science, systems, and routine O&M. The

Whole Building programs, on the other hand, focus on facility-specific needs or properly maintaining specific equipment, usually the equipment to be installed. For instance, this might include how to manage inventory practices for new lighting fixtures or how the proposed new equipment would affect settings, controls, and maintenance schedules.

While this training is highly valuable for enhancing O&M, it is not sufficient nor intended to replace the expertise provided by contractors/raters/building analysts or the modeling they provide to calculate estimated energy savings and financial payback. Thus, there is an opportunity to take advantage of the synergies between BPI/BOC training and the PA programs to provide a comprehensive package of services to MF staff.

For detailed findings from our review of PA multifamily programs, please refer to the “Program Administrator Interview Findings” memo in Appendix G.

5. Conclusions and Recommendations

The limited number of survey respondents ultimately prevented this study from making generalizable conclusions about the value of BPI and BOC training. However, our findings do suggest that the additional O&M training has the potential to deliver energy savings and non-energy benefits to the multifamily sector. Thus, we recommend that the CPUC and/or IOUs conduct further research into this area. Specifically, we recommend the following:

- **Focus on BPI MFBO training:** We recommend that future research focus specifically on BPI MFBO training, as this is a training attended predominately by multifamily building owners, managers, and maintenance staff. Through we found some evidence that the BOC training includes some MF staff, the BOC training primarily targets commercial building operators. Further, NEEC does not have the data tracking systems in place to properly identify multifamily participants. Should the CPUC and/or NEEC seek to determine the energy savings potential of BOC training in the multifamily sector, additional data tracking will be necessary to identify multifamily participants. Most importantly, NEEC should consider including an identifier flag in the data that indicates whether a participant oversees or maintains a multifamily property. With this data, future evaluations can identify MF staff by looking for "multifamily" participants in the "property management" or "other" categories.

- **Identify strategies for increasing response rates:** Lack of interest or time among multifamily staff to participate in research, regardless of the incentive offered, is a known challenge in the industry and was a significant limitation for this study. Thus, before any further research is conducted, we recommend that the CPUC and IOUs collaborate with multifamily program implementers, training providers (e.g., AEA and NEEC), and other industry organizations to identify improved strategies to engage and motivate multifamily staff to participate in research (e.g., survey mode, survey length, outreach methods, incentive types and levels, best times to contact them, etc.). These types of organization can provide expertise on outreach strategies to this sector and can serve as credible messengers for research efforts.

- **Include non-participants to fully understand training needs:** This study was intended to understand the motivations and benefits to O&M training among training participants and their companies. The study also gathered insights from multifamily program implementers to understand potential O&M training needs in the market. The next step would be to get a full picture of O&M training needs and barriers to getting training in the multifamily market by including MF staff who have not received any O&M training. This research should also explore whether the BPI MFBO and/or BOC's list of course topics align with those needs. For example, some systems (e.g., boilers and chillers), may not be applicable to the majority of California multifamily properties.

- **Cost comparison:** The CPUC should compare the costs of providing additional O&M marketing, education and outreach (ME&O) to the costs of incentivizing BOC/BPI training. Marketing might be a more cost-effective alternative. While this was not a key focus of this study, we collected a few basic facts as a starting point. In 2013-2015, the BOC training cost $1,495 for California residents. AEA's BPI training typically[10] costs $1,200 with an additional $750 exam fee. Insufficient data was available to assess the ME&O costs per-participant for the Multifamily Whole Building programs.

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[10] Notably, the AEA provided the MFBO training for free in 2013-2015 due to IOU program funding. This cost estimate is based on a review of the AEA website's list of course offerings as of October 6th, 2017.

Appendix A. Detailed Description of BOC and BPI Training

Description of the Building Operator Certification Program

Below is a description of the BOC program based on the 2010-2012 BOC Impact Evaluation[11], our interview with Northwest Energy Efficiency Council (NEEC) staff, and our review of data and materials that NEEC provided.

BOC is a nationally recognized energy efficiency training and certification program founded on the principle that trained and motivated building operators can significantly reduce energy consumption. The BOC program funded by the California IOUs (through the Workforce Education & Training "Centergies" sub-program) and administered by NEEC, provides in-depth and hands-on experience to professionals in the building O&M field.

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 O&M. The program provides two levels of training and certification, both designed to improve job skills and lead to improved comfort and energy efficiency at participants' facilities. The Level I course series focuses on expanding knowledge of building systems equipment and best practices for their efficient operation, with an emphasis on HVAC controls, common opportunities for operational improvements, and building scoping for energy efficiency. Level II students gain experience in preventative equipment maintenance and other targeted training topics.

NEEC designed the certification for building operators with two or more years of experience in building O&M, including building engineers, maintenance supervisors, maintenance workers, operations technicians, and others in the facility operation and maintenance field. IOU program funding does not cover 100% of the cost of certification. The participant's employer contributes the remaining balance ($1,495 for California residents, $1,695 for non-residents), with a discounted fee offered for each additional employee ($995 or $1,495 for residents or non-residents, respectively).

To remain certified, a building operator must accumulate five "maintenance points" per year for Level I and ten per year for Level II. Building operators may obtain these points by providing NEEC with documentation of completion of qualified activities, including extended learning courses that NEEC has approved, technical webinars provided on the BOC website, completion of special facility projects, completion of BOC Newsletter quizzes, or documentation of involvement with relevant trade organizations. Various national and regional organizations[12] offer continuing education courses that are applicable to annual BOC certification renewal.

As of 2016, NEEC has launched an initiative to align the BOC program with the International Organization for Standardization (ISO) Standard 17024. While the BOC exam has previously been "open book" and a part of the BOC training courses, the new format requires a separate exam by a third party (with a separate fee) and that the test be "closed book." For those professionals who take the courses but do not take the test, NEEC will issue a Training Certificate of Completion (TCOC). Any Level I or II certification earned prior to 2016 will automatically convert to a TCOC and certificate holders have the opportunity to take the certification exam free of charge. According to NEEC, they implemented these changes to increase both the rigor and value of BOC certification. While these changes do not affect 2013–2015 participation, they do present significant cost, time, and effort barriers and could potentially lower the number of certificate holders in the future.

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[11] Opinion Dynamics. February 2014. Impact Evaluation of the California Statewide Building Operator Certification Program. CALMAC ID: CPU0069.01.

[12] For example, Building Owners and Managers Institute (BOMI) International's Systems Maintenance Technician (SMT) related courses. http://www.theboc.info/why-boc/boc-bomi-partnership/

Curriculum and Courses Offered

Level I is an eight-day series of courses that provides an overview of critical building systems. Courses generally occur a month apart, and each include lectures, work in small groups, building tours, tests and assignments, and the performance of related work at one's own facility. Building operators must complete six core curriculum courses and one supplemental course (seven total) to earn Level I certification. Level II is a subsequent series of classroom courses that emphasize preventative maintenance and more targeted training. Building operators must complete four core curriculum courses and two supplemental courses (six total) to earn Level II certification.

Table 31 lists the current curriculum for BOC Levels I and II.

Table 31. Level I and II BOC Curriculum

Course Name
Level I Core Courses
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 Courses (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 Energy Efficient Ventilation Strategies and High Performance Heating and Cooling Equipment
BOC 1011 Energy Efficient Ventilation Strategies and Energy Savings through Energy Recovery
BOC 1012 High Performance Heating and Cooling Equipment and Energy Savings through Energy Recovery
Level II Core Courses
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 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

Multifamily Participation in BOC Training

It is important to note that the BOC curriculum targets anyone managing very large buildings or multiple buildings. The majority of participants are large commercial facility property managers, although early findings from a recent study by Evergreen Economics notes that BOC trainings could apply to "operators of larger multifamily buildings with centralized systems". However, they suggest that BOC "would serve the needs of those with smaller buildings in only a limited way", as centralized HVAC systems are not common among smaller facilities. They suggest "better serving the needs of operators of small multifamily buildings would require a more substantial redesign or might be accomplished by inviting these operators to selected training days only".[13]

To identify the BOC population for this study, we began by analyzing NEEC's BOC participant database for information that would help identify the MF staff. However, we discovered that the database does not directly differentiate multifamily property managers from other types of facility managers. NEEC collected the market sector of each participant, which we present in Table 32 below. However, the BOC program did not track participation specifically from the multifamily sector. Out of 631 participants that received certification, 23% of them (or 143 participants) identified market sectors that may include MF staff ("property management" and "other", highlighted below).

Table 32. PY2013-2015 BOC Participants by Market Sector (Level I and II)

Market Sector	Level I Only (N= 570)	Level II Only (N=263)	Both Level I & II (N=213)	Any Certification (N=631)
College/University	29%	37%	35%	30%
Government	22%	24%	28%	22%
Property Management	15%	14%	13%	15%
Healthcare	8%	5%	5%	7%
K-12 School	6%	3%	3%	6%
Manufacturing	5%	7%	6%	6%
Hospitality	2%	3%	3%	2%
Municipality	2%	1%	0%	2%
Retail	2%	1%	1%	2%
Military	0%	1%	0%	0%
Government (not city/state specific)	0%	0%	0%	0%
Other	8%	4%	4%	8%
Total	**100%**	**100%**	**100%**	**100%**

Next, through internet searches we reviewed the workplace addresses, Google Maps imagery, and company websites of each of these 143 potential multifamily participants. As shown in Table 33 below, 84 of these participants appear to work at multifamily properties and represent the BOC portion of our study population.

Table 33. Number of PY2013-2015 Property Manager and Other BOC Participants

Market Sector	Possible MF Staff	Identified as Likely MF Staff	% Identified
Property Management	93	82	88%
Other	50	1	2%
Total	**143**	**83**	**58%**

[13] Evergreen Economics, Memo to the Multifamily Process Evaluation Study Team, Re: Training Study Task Update, March 25, 2016

As seen in Table 34, further analysis of the data revealed that many participants work at the same companies and locations. However, we will attempt to contact all participants for our survey, even if they belong to the same company. Because these participants may have worked on the same projects, we will carefully review projects and ask survey questions on shared responsibility to avoid double counting.

Table 34. Unique Locations and Companies among BOC Multifamily Participants

Total Multifamily Participants	Unique Property Locations	Unique Companies
84	49	24

Follow-up on 2010-2012 Study Recommendation

In the 2010-2012 BOC Impact Study, we identified a number of recommendations for improving NEEC's data tracking practices. These recommendations included tracking:

- Hours of operation—both weekly schedule and periods in which the facility is inactive for more than half of the month
- If the participant's company owns their facility or rents/leases it
- If the participant has direct influence over energy management decisions at their facility
- Precise square footage of both the facility and the portion of the facility for which the participant is responsible[14]
- Number of other facility employees that will be BOC-certified after the completion of the current curriculum; and
- Primary utility account number(s)

During our interview, NEEC staff reported that while they considered ways to implement these recommendations, they have not been able to do so. The key barriers to collecting this information included that participants did not know this information or did not have it readily available during the classes. Further, even when participants did provide information on their facility, they often did so "off the top of their head", and thus some information may not be accurate.

Description of the BPI Multifamily Training

Below is a description of the BPI multifamily trainings based our review of the BPI website, an interview with the Association for Energy Affordability (AEA), and the participant data and course materials that AEA provided.

BPI is a national standards development organization for residential energy efficiency and weatherization retrofit work. The American National Standards Institute (ANSI) accredits BPI as an approved developer of American National Standards. BPI's Standards Technical Committee creates performance standards using an expert consensus-based methodology. BPI certifies contractors using a "house-as-a-system" approach and is an industry standard of efficiency performance for the Home Performance with ENERGY STAR® program from

[14] NEEC collects total building square footage in most cases, but not the square footage of the portion for which the participant is responsible.

the U.S. Department of Energy (DOE) and Environmental Protection Agency (EPA), as well as several state Weatherization Assistance Programs.

BPI offers several types of certification, including entry level, advanced, and a specific certification for BPI raters. BPI does offer specific certifications for multifamily building analysts (MFBA) as well as multifamily building operators (MFBO). According to AEA, the MFBA certification targets consultants or contractors who work with multifamily properties. While MFBO topics are very similar to MFBA, MFBO targets multifamily property managers and has more focus on maintaining and monitoring building systems. Thus, MFBO is the focus of our study.

ANSI has positioned BPI as an accreditation, not one defined set of courses. Each training center offers its own curriculum that covers the topics in the BPI certification test. For multifamily certification, there are seven test centers across California (see Table 35 below) but AEA is the only organization that offered multifamily certification training courses in 2013-2015. According to AEA, BPI provided the multifamily training courses in California free of charge. However, the certification exam had a separate cost of $750 ($500 for the practical exam and $250 for the written). While we will confirm this in our participant survey, AEA staff mentioned that employers often sponsored their employees' travel, accommodation, and exam costs.

Table 35. BPI Multifamily Building Operator Certification Testing and Training Centers

Name	Location
Association for Energy Affordability	Emeryville, CA
Building Performance Center, Inc.	Folsom, CA
CalCERTS, Inc.	Folsom, CA
Cosumnes River College	Sacramento, CA
Energy Efficiency Management, Inc.	Fullerton, CA
Healthy Homes4U, Inc.	Costa Mesa, CA
Partner Energy, Inc.	Sacramento, CA

AEA offered five MFBO trainings in 2013-2015. They received funding for these courses from a variety of sources, including some ratepayer dollars. The first three courses (2013-2014) received funding from the Alameda County Waste Management Authority (ACWMA) and American Recovery and Reinvestment Act (ARRA). In 2015, PG&E funded two additional courses through their Local Government Partnership (LGP) Strategic Energy Resources budget.[15]

Recertification is required every three years, achieved by accumulating thirty continuing education units. Participants earn these units by completing BPI approved coursework, again offered by independent training organizations, and submitting proof of completion through the BPI website.

Curriculum and Course Offerings

BPI organizes the topics tested in its MFBO certification into five modules, as shown in Table 36 below.

[15] Source: Information provided by StopWaste (governed in part by the ACWMA).

Table 36. BPI MFBO Certification Skills Tested

Module	Title	Brief Description
1	Building Science	Basic heat transfer, building envelope, air conditioning, airflow.
2	Auditing/Reporting Skills	Understanding contractor scopes of work, building controls, training maintenance staff, heat, moisture, and maintenance tracking systems.
3	Inspection and Diagnostic Skills	Diagnostic equipment, diagnosing heating/cooling complaints, duct and envelope diagnosis and maintenance, roof maintenance.
4	Installation/Analysis Skills	Maintenance schedules, oversee contractors for correct installation, water control settings, appliance replacement protocols.
5	Health and Safety	Common health issues related to building maintenance, pest response, CO2 issues, dust management, mold management, building security.

AEA offered five MFBO certification courses between 2013 and 2015 in two slightly different formats. Most participants attended the five-day "Multifamily Green Building Operator" course in 2013 or 2014, including one day of general green building principles topics, four days of MFBO exam preparation (covering the modules in Table 36), and the MFBO exam on the last day.[16] In 2015, AEA delivered the training as a four-day class without the green building principles section, which they branded the "BPI Multifamily Building Operator Class". Regardless of the specific format, the three core days of exam preparation included the following activities and topics:

- **Day One:** Creating an energy management plan; maintenance, diagnostic and building science topics
- **Day Two:** HVAC and hot water topics
- **Day Three:** Lighting and appliances topics and a site visit

According to AEA, the site visits typically include a full walkthrough of a multifamily facility and a discussion of the processes and systems covered in class. Throughout the visit, the instructor asks trainees to point out and discuss concepts or provide suggestions for what they might do to diagnose and improve the energy efficiency of the space. Trainees also practice using diagnostic equipment, like infrared temperature guns and gas leak detectors. AEA reports that they focus on equipment that is affordable and practical for multifamily facilities, rather than expensive equipment such a duct blasters and blower doors.

As shown in Table 37, 120 multifamily property owners received BPI MFBO training in 2013, 2014, or 2015 representing the BPI portion of our study population.

Table 37. BPI Multifamily Participants, Locations and Companies

Total BPI Participants			Unique Property Locations	Unique Companie s
2013-14 5-Day Course	2015 4-Day Course	2013-2015 Total		
88	32	120	22	62

[16] While AEA built the exam into every course (for an additional fee), actually taking the exam was optional.

Appendix B. Detailed List of BOC and BPI Actions

Below is a list of actions building operators could have learned about through BOC and BPI training. We originally developed this list during the 2010-2012 BOC Impact Evaluation. After reviewing BPI Multifamily course materials, we found that potential actions participants could have learned about during BPI training were largely consistent with BOC. However, we have added 10 additional actions specific to BPI.

Table 38. List of BOC and BPI Potential Actions

Measure Category/Measure Name	Included in BOC	Included BPI
Boiler/Hot Water/ Steam System		
Tune up boiler	✓	✓
Install hot water pump variable frequency drive (VFD)	✓	✓
Hot water supply temperature reset	✓	✓
Install combustion fan VFD	✓	✓
Test and replace faulty steam traps	✓	✓
Reset supply water temperature based on load	✓	✓
Replace conventional gas boilers with condensing boilers	✓	✓
Minimize blowdown of steam boilers	✓	✓
Monitor makeup water for steam boilers	✓	✓
Monitor pump operating pressures	✓	✓
Match boiler capacity to load with multiple boilers or high turndown ratio	✓	✓
Implement heat recovery with exhaust gas heat exchanger	✓	✓
Insulate steam and water piping	✓	✓
Chiller / Chilled Water System		
Balance water side	✓	✓
Chilled water temperature reset based on load	✓	✓
Optimize chiller sequencing	✓	✓
Maintain operating logs	✓	✓
Monitor pump operating pressures	✓	✓
Use water side economizer	✓	✓
Insulate chilled water piping	✓	✓
Thermal storage systems	✓	✓
Install evaporative cooling system	✓	✓
Optimize part load efficiency with multiple chillers or variable speed compressors	✓	✓
Measure and optimize chiller performance	✓	✓
Install absorption cooling systems	✓	✓
Cooling tower optimization		
Reset condenser water temperature	✓	✓
Condenser water temperature optimization	✓	✓
Misc. cooling tower optimization	✓	✓
Cooling tower maintenance to for optimum operation	✓	✓
Use variable speed condenser fans for capacity control	✓	✓
Domestic Hot Water		
Install low-flow faucets, shower heads and pre-rinse spray valves	✓	✓
Install tankless water heaters	✓	✓
Install solar water heating	✓	✓

Measure Category/Measure Name	Included in BOC	Included BPI
Economizer and Ventilation control		
CO-based ventilation control	✓	✓
CO2 based Demand control ventilation	✓	✓
Use economizer and outdoor air control	✓	✓
Reduce ventilation	✓	✓
Repair economizer	✓	✓
Schedule heaters	✓	✓
Reset supply air temperature	✓	✓
Use natural ventilation	✓	✓
Building pressurization control	✓	✓
Night purge cycle for pre-cooling	✓	✓
Economizer commissioning	✓	✓
Heat recovery systems	✓	✓
Maintain washer/dryer venting in common areas and in unit	✗	✓
Equipment Scheduling		
Optimum start for air handling unit (AHU)	✓	✓
Match AHU schedule to space occupancy	✓	✓
Schedule boilers	✓	✓
Schedule exhaust fans	✓	✓
Schedule fan-powered boxes	✓	✓
Schedule fan-powered/VAV boxes	✓	✓
Schedule heaters	✓	✓
Schedule pumps	✓	✓
Schedule return/exhaust fans	✓	✓
Set back space temperature (electric baseboard)	✓	✓
Reset supply air temperature	✓	✓
Schedule central laundry	✗	✓
Schedule elevators	✗	✓
Schedule kitchen facilities	✗	✓
Schedule trash compactors	✗	✓
Fan optimization/Air Distribution		
Balance airside	✓	✓
Demand control ventilation	✓	✓
Reduce/reset duct static pressure	✓	✓
Install efficient filters/Filter maintenance	✓	✓
Optimize supply fan performance	✓	✓
Optimum start for AHU	✓	✓
Reduce simultaneous heating and cooling	✓	✓
Reduce variable-air-volume (VAV) minimum position	✓	✓
Reduce ventilation	✓	✓
Repair/replace dampers	✓	✓
Schedule AHU and duct static pressure reset	✓	✓
Schedule AHU for space	✓	✓
Schedule return/exhaust fans	✓	✓
Reset supply air temperature	✓	✓

Measure Category/Measure Name	Included in BOC	Included BPI
Utilize VFDs for fans	✓	✓
Clean heat exchangers and coils	✓	✓
Commission air systems	✓	✓
Seal ductwork	✓	✓
Insulate ductwork	✓	✓
Building warm-up cycle	✓	✓
Weather- Strip doors and windows	×	✓
Caulk and seal bathrooms (tub, countertops, sinks)	×	✓
Lighting		
Match schedule to occupancy/Schedule lighting	✓	✓
Utilize daylighting	✓	✓
Reduce lighting loads (do not over-light)	✓	✓
Reduce lighting loads (use efficient sources)	✓	✓
Commission control systems	✓	✓
Schedule/Conduct Lighting Audit	✓	✓
Install occupancy sensors	✓	✓
Install vacancy sensors	✓	✓
Install photocells on interior fixtures (skylights/window walls)	✓	✓
Install lighting control panels (sweep/timers)	✓	✓
Replace magnetic T12 fluorescent ballasts with electronic ballasts and T8/T5 lamps	✓	✓
Replace High Intensity Discharge fixtures with energy efficient technology	✓	✓
Replace standard wattage T8's with reduced wattage T8's	✓	✓
Replace F54T5HO's with reduced wattage T5HO's	✓	✓
Replace incandescent exit signs with light emitting diodes (LEDs)	✓	✓
Replace incandescent lamps with CFLs/LEDs	✓	✓
Install new high-efficiency fixtures (80%+ efficacy)	✓	✓
Replace stairwell lights with bi-level fixture w/sensor	✓	✓
Re-lamp and clean fixture housings and lenses	✓	✓
Evaluate exterior lighting for replacement/retrofit opportunities	✓	✓
Evaluate exterior lighting for control savings	✓	✓
Pump optimization		
Adjust freeze protection sequence for pumps	✓	✓
Impeller trimming	✓	✓
Improve chilled water and how water flow control	✓	✓
Reduce flow by increasing system Delta T	✓	✓
Schedule pumps	✓	✓
Utilize VFD for pumps	✓	✓
Energy Accounting		
Determine facility energy use intensity; conduct energy use analysis	✓	✓
Use Energy Star Portfolio Manager to benchmark building performance	✓	✓
Apply for Incentives/Tax Credits		
Determine potential EE project (scope of work defined)	✓	✓
Contact utility representative	✓	✓
Obtain bids/pricing for scope of work	✓	✓
Research funding available from utility programs	✓	✓

Measure Category/Measure Name	Included in BOC	Included BPI
Research available State tax credit programs	✓	✓
Research available Federal tax credit programs	✓	✓
Obtain necessary pre-approval application from local utility	✓	✓
Complete and submit application for pre-approval	✓	✓
Complete project	✓	✓
Obtain necessary payment application from local utility	✓	✓
Complete and submit information for payment from local utility	✓	✓
Complete and submit information for tax credits	✓	✓
Other		
Implement renewable energy to reduce utility energy consumption	✓	✓
Minimize plug loads	✓	✓
Envelope efficiency improvements (insulation, cool roofs, air sealing, etc.)	✓	✓
Install high efficiency condensing boilers and furnaces	✓	✓
Implement net-zero strategies	✓	✓
Implement a conservation policy	✓	✓
Test, and respond to natural gas leaks	×	✓
Test efficiency for stoves/ovens	×	✓
Test efficiency of central laundry	×	✓

Legend: ✓ included; × not included

Appendix C. Detailed List of BPI Multifamily Course Topics

Below is a detailed list of topics the BPI multifamily modules cover.

Table 39. Detailed List of Topics Covered in BPI Modules

Module	Topic
Module 1 – Building Science	
1	Understand basic heat transfer mechanisms
1	Understand moisture transport mechanisms
1	Understand relative humidity, condensation, and how they are related to comfort
1	Basic principles of air conditioning
1	Understand multifamily building airflow characteristics (single zone, parallel floor, compartmentalization, etc.)
1	Understand and identify typical multifamily ventilation system design strategies and applications
1	Associate interaction of stack effect and airflows in ventilation stacks
1	Understand air leakage issues related to elevators
1	Understand the difference between nominal and effective R-value
1	Understand IAQ pollutant transport mechanisms
1	Understand basic combustion science
1	Understand combustion technologies
1	Understand how heat recovery works for ventilation systems
1	Understand how heat recovery works for domestic hot water systems
1	Identify correct foot-candle requirements for light levels in different areas of the building
1	Associate relationship between lighting/appliance retrofits with internal gains and heating/cooling loads
1	Be familiar with proper de-manufacturing and disposal procedures for appliances and lighting components
1	Basic understanding of electrical systems
1	Understand how a building envelope works
1	Define air barrier
1	Define thermal barrier / boundary
1	Describe how wall assemblies effect the drying ability of the wall when water intrusion occurs
1	Define flashing and examples of use
Module 2 – Auditing/Reporting Skills	
2	Basic knowledge of operation and major parts of furnace distribution systems
2	Ability to read instructions and follow them for distribution controls
2	Basic knowledge of ventilation (exhaust, intake, leakage) as well as codes
2	Ability to know the scope of work for a contractors and ensure proper installation
2	Ability to schedule and stage work effectively and efficiently
2	Evaluate the flow of combustion products out of the building
2	Ability to use simple tools to follow flow of combustion air and identify back drafting and spillage
2	Need to identify tell-tale signs of back drafting, spillage, and condensation in the flue
2	Relationship between boiler water aqua stat settings, DHW temp and cost of maintaining
2	Knowledge of control settings
2	Knowledge of mixing and tempering valves
2	Ability to distinguish between routine maintenance tasks and basic repair work

Module	Topic
2	Understand energy efficient lighting options and design including controls
2	Develop protocols for lighting replacement in areas of building owner responsibility
2	Understanding of utility bills and usage patterns including demand
2	Establish comprehensive lighting schedule and procedures for planned replacement
2	Train maintenance staff on procedures
2	Train maintenance staff and residents on proper operation
2	Understand reasons to keep and use logs
2	Ability to create a log from a set of data
2	Translate information on logs into action steps
2	Create and maintain systems for the safekeeping of records, logs
2	Maintain professional licenses as required by governmental regulations
2	Develop and maintain a system for tracking and completing work orders
2	Develop Vendor files for storage of contracts, invoices and other information pertinent to the vendor relationship
2	Develop and maintain a system for tracking utility use
2	Identify components of typical wall assemblies that make up the envelope and understand their functions
2	Identify various structural systems
2	Identify typical roof assemblies
2	Identify common exterior finishes
2	Describe an air barrier and its function in a building
2	Identify proper air barrier materials
2	Identify moisture tolerant materials for areas that are high risk for moisture
2	Identify common types of insulation
2	Identify the signs of deterioration for common exterior finishes
2	Identify typical causes of deterioration
2	Identify examples of improperly installed and/or deteriorating flashing
2	Know different types of doors and windows to characterize their energy performance
Module 3 – Inspection/Diagnostic Skills	
3	Diagnose heating/cooling imbalance and correct basic complaints
3	Basic knowledge of distribution, balancing, bleeding
3	Knowledge of one pipe vs. two pipe systems
3	Knowledge of tankless and sidearm hot water makers
3	Knowledge of boiler pressure, low fire pressure, modulating pressure
3	Difference between pressure troll and vapor stat
3	Ability to test ventilation performance with little to no equipment
3	Ability to determine duct insulation levels
3	Ability to determine duct sealing needs
3	Basic A/C maintenance, cleaning filters
3	Record flue temperatures
3	Record daily fuel usage in logs for tracking of building efficiency and need for maintenance
3	Knowledge of paper and/or electronic log book systems
3	Ability to analyze and interpret log data and take appropriate corrective action
3	Water temperature testing at taps and shower heads

Module	Topic
3	Perform periodic maintenance and repair of water heaters and tanks
3	Identify when the envelope has failed
3	Working knowledge of energy management system and how to read and control system for maximum efficiency
3	Reduce or eliminate potential sources of standing water
3	Conduct regular inspections of roof for possible damage and potential leaks
3	General understanding of diagnostic equipment and procedures
3	Train on proper utilization of diagnostic equipment
3	General understanding of testing procedures/efficiency for stoves/ovens
3	Establish ongoing testing protocols
3	Interpret and analyze usage data and communicate information to other decision makers
3	Identify areas that need weatherstripping
3	Know proper materials to be used for caulking
3	Demonstrate how to conduct a basic roof inspection
3	Identify common reasons for water penetration
3	Know routine maintenance tasks for various kinds of roofs
3	Maintain integrity of boundaries between interior conditioned space and attached or underground garages or mech. rooms
Module 4 – Installation/Analysis Skills	
4	Ability to schedule and stage work effectively and efficiently
4	Evaluate the flow of combustion products out of the building
4	Ability to use simple tools to follow flow of combustion air and identify back drafting and spillage
4	Identify tell-tale signs of back drafting, spillage, and condensation in the flue
4	Knowledge of indirect, tankless, and sidearm hot water makers
4	Relationship between boiler water aqua stat settings, domestic hot water temp
4	Knowledge of hot water control settings
4	Knowledge of hot water mixing and tempering valves
4	Maintain hot water temperature to meet all relevant health and safety codes
4	Identify and avoid unsafe hot water temperatures
4	Establish a maintenance schedule for building-owned equipment including: trash compactors, central laundry and kitchen facilities, etc.
4	Ensure proper seal/closing of trash chutes
4	Maintain records and logs as appropriate
4	Develop protocols for replacement of appliances
4	Ensure proper maintenance of washer/dryer venting in common areas and in unit
4	Simple maintenance such as caulking/ weather-stripping
4	Materials commonly used as thermal barriers and proper applications
4	Identify materials commonly used as moisture barriers and proper application
4	Distinguish when repair vs. replacement of doors and windows is needed
Module 5 – Health and Safety	
5	Understand health ramifications of product selection
5	Maintain and understand material safety data sheets on all products
5	Understand common health issues related to building management practices

Module	Topic
5	Identify / correct fall/trip/slip areas in apartments and common areas
5	Understand, measure, and correct light levels
5	Proper use of tools
5	Effectively ask questions to residents regarding building management health considerations
5	Apply air sealing and related tobacco smoke mitigation
5	Develop tobacco smoke response strategy
5	Apply air sealing and related pest mitigation
5	Develop pest response strategy
5	Develop health-related complaint response strategy
5	Apply Evaluation and feedback techniques to gauge changes in building's resident health considerations.
5	Be able to measure and correct carbon monoxide problems
5	Understand and apply environmental hazard management requirements
5	Be able to monitor, identify, test, and respond to natural gas leaks
5	Prepare and apply a critical health and safety checklist - apartments, common areas, mechanical rooms
5	Educate residents about apartment/ resident health and safety maintenance requirements
5	Understand and apply Health and Safety drill management best practices
5	Reduce impact of dust migration into building/ apartments
5	Apply New York City mold mitigation guidelines
5	Maintain apartment and common area thermal comfort per guidelines
5	Identify and prevent burn possibilities
5	Follow Integrated Pest Management best practices
5	Follow worker safety personal health best practices.
5	Maintain a secure building. Evaluate performance.
5	Maintain safe elevators, identify, check, and anticipate potential elevator problems
5	Develop and apply an electrical inspection protocol. Understand safe electric system best practices
5	Cooling Tower chemical treatment/ operation/ monitoring considerations HVAC
5	Identify need and install tip control brackets for equipment, appliances, and furnishings that may pose a safety hazard
5	Be aware of commercial space health and safety issues.

Appendix D. Additional Property and Participant Characteristics

Below we provide additional detail on survey respondents and their properties.

Property Characteristics

Ownership structure varied significantly, though most respondents (8 of 13) stated their company owns at least some of the properties they oversee.

Table 40. Property Ownership Structure

Response	Number of Respondents (n=13)
Company Owns	6
Owns, Non-profit organization	*3*
Owns, Partnership	*1*
Owns, Privately-owned/Family-owned	*1*
Owns, Ownership structure unknown	*1*
Company Does Not Own	4
Contracted property management company	*3*
Leases or rents	*1*
Mixture of Own and Rent	2
Don't know	1

Table 41 summarizes the additional property characteristics covered in the survey. According to the U.S. Census[17], most properties (24 of28, or 86%) are classified—in terms of number of units—as large multifamily properties. Additionally, there was a high concentration of low income housing, all of which are overseen by BPI-certified respondents. This is to be expected, as many trainees sought out the BPI training to meet requirements of the California Tax Credit Allocation Committee (TCAC) low-income tax credit. Notably, many respondents did not know their properties' total square footage or annual energy costs.

Table 41. Property Characteristics

Response	Number of Properties (n=28)
Number of Units	
1 – 9	3
10 – 24	0
25 – 49	1
50 – 99	3
100 – 249	12
250 – 499	4
500 or More	4
Don't know	1

[17] A large multifamily property is defined as 50 or more units. Source: American Community Survey Three Year Estimates 2009-2011 (U.S. Census Bureau 2011)

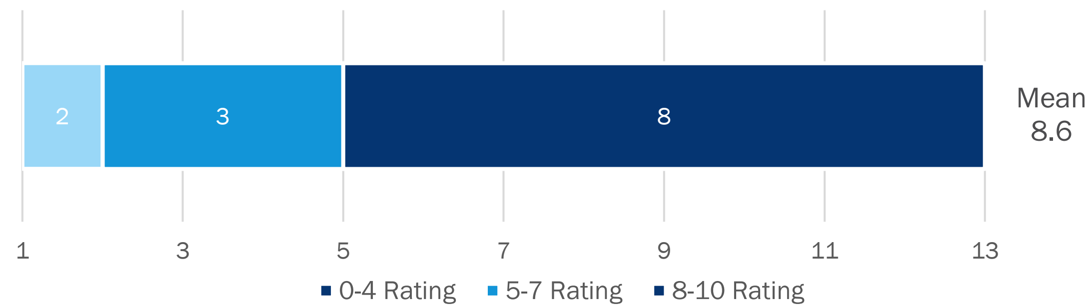
Response	Number of Properties (n=28)
Percent of Low-Income Units*	
None	7
1 – 25%	4
26 – 50%	3
51 – 75%	2
76 – 99%	1
All	11
Number of Residents	
1 – 9	3
10 – 24	0
25 – 49	1
50 – 99	3
100 – 249	12
250 – 499	4
500 or More	4
Don't know	1
Total Square Footage	
Under 25,000	6
25,001 – 75,000	4
75,001 – 250,000	4
250,001 – 750,000	5
750,001 – 1,000,000	0
Over 1,000,000	3
Don’t Know	6
Total Annual Energy Costs	
0 – $20,000	1
$20,001 – $30,000	1
$30,001 – $40,000	3
$40,001 – $50,000	1
Over $50,000	2
Don’t Know	20

* ”Low income” is defined as Section 8-subsidized or deed-restricted affordable housing.
Blue highlights indicate concentrations of responses.

Roles and Responsibilities

Respondents typically hold a key decision-making position at the company. Titles varied widely, ranging from high-level positions like “regional manager” or “owner” to supporting positions such as “property management assistant". Overall, when asked on a scale of 0 to 10, with 10 being "a great deal of influence" on investment decisions[18] most (8 of 13) cited they had 8 or greater influence.

Figure 10. Property Influence (n=13)



Scale from 0 to 10 where 0 is "no influence at all" and 10 is "a great deal of influence"

Most respondents work with multiple people at the company to make decisions. Other staff involved in the decision-making process included superiors (i.e., owners, investors, regional managers, other property managers on site) as well as other maintenance and operations staff reporting to them. Most participants stated they had the ability to make decisions up to a certain dollar amount (9 of 13), with three respondents stating a dollar amount below $5,000, two respondents indicating a dollar amount between $5,000 and $10,000, and four preferring not to answer. Table 42 summarizes respondents' roles and responsibilities at the properties they maintain.

Table 42. Roles and Responsibilities

Response	Number of Respondents (n=13)
Properties Overseen/Maintained	
1	5
2	1
3	0
More than 3	7
Number of Staffed Managed	
None	4
1 to 4	2
5 to 10	2
11 to 20	2
More than 20	3
Staff Involved in Decision Making	
One	3
Multiple	10

[18] Specifically, we asked about influence on investments in new equipment, equipment repairs, or operations and maintenance practices at the properties they oversee.

Response	Number of Respondents (n=13)
Ability to Make Investments up to a Certain Dollar Amount	
Yes	9
No	4

Appendix E. Gross Savings Analysis Detailed Methods

As previously mentioned, the evaluation team applied IOU-claimed savings to actions that received incentives from IOU multifamily programs and calculated custom gross savings using data gathered from in-depth interviews for actions that were not rebated. Table 43 presents the gross savings analysis approach we applied to each energy-saving action.

Table 43. Gross Savings Analysis Approach

Case Study	Category	Action	Applied IOU-Claimed Savings	Calculated Custom Savings
1	Lighting	Replaced 40W – 55W fluorescents with LEDs		✓
2	Lighting	Installed LED A-lamps and fixtures	✓	
2	Domestic Hot Water	Installed low flow showerheads	✓	
2	Domestic Hot Water	Installed low flow aerators	✓	
2	Domestic Hot Water	Installed low flow devices	✓	
2	Economizer/Ventilation/Air distribution	Installed fan controlled devices	✓	
2	Water Pump	Installed demand control recirculation pump	✓	
2	Water Pump	Installed variable high speed pool pumps	✓	
3	Lighting	Replaced 40W – 75W equivalent CFLs, halogens, and incandescents with LEDs		✓
3	Lighting	Installed CFL lamps and fixtures	✓	
3	Lighting	Installed motion sensors		✓
3	Domestic Hot Water	Installed energy efficient gas water heaters		✓
3	Water Pump	Installed energy efficient water pumps		✓
3	Appliances or kitchen equipment	Installed energy efficient refrigerators	✓	
4	Boiler	Boiler replacement with new controls		✓
4	Domestic Hot Water	Installed low flow showerheads	✓	
4	Domestic Hot Water	Installed low flow aerators	✓	

The evaluation team calculated custom gross energy savings by applying the algorithms presented below. The evaluation team incorporated measure-specific data provided by the respondents during in-depth interviews whenever possible. However, we relied on the Illinois Statewide Technical Reference Manual Version 6.0 (IL-TRM V6.0), the Database for Energy Efficient Resources (DEER), and the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) when this information was not available.

A.1 LED Algorithms

The evaluation team calculated gross savings for LED upgrades by applying savings algorithms from the IL-TRM V6.0 and assumptions provided in Table 44.

Equation 1. LED Algorithms

Energy Savings: $\Delta kWh = Qty * ((WattsBase - WattsEE) / 1{,}000) * ISR * Hours * WHF_e$

Demand Savings: $\Delta kW = Qty * ((WattsBase - WattsEE) / 1{,}000) * ISR * WHF_d * CF$

Where:

Qty	= Quantity of LEDs installed
$Watts_{base}$	= Wattage of existing equipment
$Watts_{EE}$	= Wattage of installed LEDs
1,000	= Watts per kilowatt
ISR	= In-service rate of installed LEDs
Hours	= Annual hours of use
WHF_e	= Waste heat factor for energy (accounts for cooling savings from efficient lighting)
WHF_d	= Waste heat factor for demand (accounts for cooling savings from efficient lighting)
CF	= Summer peak coincidence factor

Table 44. Variable Assumptions for LEDs

Variables	Value			Resource
	Case Study 1	Case Study 3		
Qty	20	180	68	Actual[19] quantity of LEDs installed
$Watts_{base}$	47.5	57.5	57.5	Actual baseline wattage
$Watts_{EE}$	13	6.7	6.7	Actual efficient wattage of LEDs
ISR	100%	100%	100%	Assumed 100% as respondents reported installed quantities.
Hours	759[a]	8,760[b]	847[a]	[a] IL-TRM V6.0 assumption for LEDs based on installation location. [b] Actual annual hours of use
WHF_e	1.00	1.00	1.00	IL-TRM V6.0 assumption for uncooled buildings
WHF_d	1.00	1.00	1.00	IL-TRM V6.0 assumption for uncooled buildings
CF	7.1%	8.1%	8.1%	IL-TRM V6.0 assumption for LEDs based on installation location

A.1 Occupancy Sensor Algorithms

The evaluation team calculated gross savings for occupancy sensors by applying savings algorithms from the IL-TRM V6.0 and assumptions provided in Table 45.

Equation 2. Lighting Control Occupancy Sensor Algorithms

$$\text{Energy Savings: } \Delta kWh = Qty * kW_{controlled} * Hours * ESF * WHF_e$$

$$\text{Demand Savings: } \Delta kW = Qty * kW_{controlled} * WHF_d * (CF_{baseline} - CF_{occupancy})$$

[19] Based on customer in-depth interview

Where:

Qty	= Quantity of occupancy sensors installed
$kW_{controlled}$	= Total wattage controlled per each occupancy sensor (in units of per 1,000 watts)
Hours	= Annual operating hours of light fixtures being controlled
ESF	= Energy savings factor that represents the reduction in operating hours
WHF_e	= Waste heat factor for energy (accounts for cooling savings from efficient lighting)
WHF_d	= Waste heat factor for demand (accounts for cooling savings from efficient lighting)
$CF_{baseline}$	= Summer peak coincidence factor for fixtures without occupancy sensors
$CF_{occupancy}$	= Summer peak coincidence factor for fixtures controlled by occupancy sensors

Table 45. Variable Assumptions for Occupancy Sensors

Variables	Value	Resource
	Case Study 3	
Qty	75	Actual quantity of occupancy sensors installed
$kW_{controlled}$	0.058	Actual total lighting load connected to the control in kilowatts
Hours	8,760	Actual total operating hours of the lighting circuit before the lighting controls are installed
ESF	66.7%	Actual reduction to the operating hours from the non-controlled baseline lighting system
WHF_e	1.00	IL-TRM V6.0 assumption for uncooled buildings
WHF_d	1.00	IL-TRM V6.0 assumption for uncooled buildings
$CF_{baseline}$	100%	IL-TRM V6.0 assumption for multifamily common area
$CF_{occupancy}$	15.0%	IL-TRM V6.0 assumption for all building types

A.2 Water Heater Algorithms

The evaluation team calculated gross gas savings for tankless gas water heaters by applying savings algorithms from the IL-TRM V6.0 and assumptions provided in Table 46.

Equation 3. Tankless Gas Water Heater Algorithms

$$\text{Gas Savings: } \Delta Therms = Qty * [[W_{gal} * 8.33 * 1 * (T_{out} - T_{in}) * [(1/EFF_{base}) - (1/EFF_{ee})]]/100{,}000] + [[(SL * 8{,}766) / EFF_{base}]] / 100{,}000]$$

Equation 4. Annual Water Use in Gallons

$$W_{gal} = Tenant\ Units * Gal\ per\ unit * 365.25$$

Equation 5. Standby Loss of Gas Baseline Water Heater

$$SL = (Input\ rating/800) + (110 * \sqrt{Tank\ Volume})$$

Where:

Qty	= Quantity of water heaters installed
W_{gal}	= Annual water use for equipment (gallons)
Tenant units	= Total number of tenant units provided hot water from water heaters
Gal per unit	= Daily water use for water heater (gallons)
365.25	= Days per year
8.33	= Weight in pounds of one gallon of water (lbm/gal)
1	= Specific heat of water (Btu/lbm/°F)
T_{out}	= Unmixed outlet water temperature (°F)
T_{in}	= Inlet water temperature (°F)
EFF_{base}	= Rated thermal efficiency of baseline water heater
EFF_{ee}	= Rated thermal efficiency of efficient water heater
100,000	= Btu per therm
SL	= Standby loss of gas baseline water heater (Btu/hr)
Input rating	= Nameplate input rating of water heater (Btu/hr)
Tank volume	= Nameplate volume of water heater (gallons)
8,766	= Hours per year

Table 46. Variable Assumptions for Tankless Gas Water Heaters

Variables	Value Case Study 3	Resource
Qty	2	Actual quantity of water heaters installed
W_{gal}	2,635,279	Calculated
Tenant Units	195	Actual number of tenant units in the multifamily building
Gal per unit	37	ASHRAE 2015 HVAC Applications assumption for multifamily buildings with 100 – 200 apartments. Section 50.15; Table 6. Hot Water Demands and Use for Various Types of Buildings.
T_{out}	122	Actual unmixed outlet water temperature
T_{in}	80	Actual inlet water temperature
EFF_{base}	80%	IL-TRM V6.0 assumption for baseline water heaters > 155,000 Btu/hr
EFF_{ee}	96%	Actual thermal efficiency
SL	3,222	Calculated
Input rating	1,500,000	Actual nameplate input rating in Btu/hr
Tank volume	150	IL-TRM V6.0 assumption for water heaters >155,000 Btu/hr

A.4 Hot Water Pump Algorithms

The evaluation team calculated gross savings for hot water pumps in by applying savings algorithms from the IL-TRM V6.0 and assumptions provided in **Table 47**.

Equation 6. Hot Water Pump Algorithms

$$\text{Energy Savings: } \Delta kWh = Qty * (BHP/EFFi * Hours * ESF)$$

$$\text{Demand Savings: } \Delta kW = Qty * (BHP/EFFi * DSF)$$

$$\text{System brake horsepower: } BHP = NHP * LF$$

Where:

Qty = Quantity of hot water pumps installed

NHP = Nominal motor horsepower (hp)

LF = Motor load factor

EFFi = Installed motor efficiency

Hours = Annual heating run hours

ESF = Energy savings factor (kW/hp)

DSF = Demand savings factor (kW/hp)

Table 47. Variable Assumptions for Hot Water Pumps

Variables	Value	Resource
	Case Study 3	
Qty	3	Actual quantity of hot water pumps installed
BHP	2	Calculated
NHP	3.0	Actual nominal motor horsepower
LF	0.65	IL-TRM V6.0 assumption
EFFi	0.93	IL-TRM V6.0 assumption
Hours	4,522	IL-TRM V6.0 assumption for high rise multifamily building
ESF	0.424	IL-TRM V6.0 assumption for hot water pump
DSF	0.000	

A.5 Boiler Algorithms

The evaluation team calculated gross gas savings for boilers by applying savings algorithms from the DEER and assumptions provided in Table 48.

Equation 7. Boiler Algorithm

$$\text{Gas Savings: } \Delta Therm = Qty * Savings * kBTUh$$

Where:

Qty = Quantity of boilers installed

Savings = Therm savings per kBTUh

kBTUh = Heating capacity of boiler (kBtuh)

Table 48. Variable Assumptions for Boilers

Variables	Value	Resource
	Case Study 4	
Qty	2	Actual quantity of boilers installed
Savings	1.09	DEER database for CZ3 (based on zip code for Case Study 4)
kBTUh	750	Actual heating capacity of boiler

Appendix F. Net Savings Analysis Detailed Methods

Free-ridership (FR) is calculated for each of the eleven actions separately. The components of each calculation are:

- Training Influence (PI): The PI score is composed of two components
  - Overall Likelihood (L): The likelihood that a respondent's company would have taken action without the training. Those who are more likely have higher FR scores.
  - Relative Influence (R): The relative influence of the training compared to other factors in the company's decision to take action. Those with lower relative influence of the training have higher FR.
- Quantity (Q): The likelihood that the respondent's company would have taken **the same number** of actions without the training. Those who would have taken the same number of actions have higher FR. Those who would have taken less actions have a lower FR score.
- Timing (PT): The likelihood that the respondent's company would have taken action **at the same time** without the training. Those who would have taken action at the same time have higher FR. Those who would have taken action have a lower FR score

*Free Ridership (FR) = AVERAGE (PI, PT) * PQ*

Below we describe the survey questions and values we used to determine each FR component.

Overall Likelihood (PI)

A1. Consider the changes made after your participation in the training program. For each of these changes, how likely would your company have been to make the same changes if you had <u>NOT</u> attended the training? [0 to 10 scale, with 0 being "not at all likely" and 10 being "very likely"].

A6. Think about each of the categories below where you said your company has made changes since the training. For each area, if you were given 10 points to show why your company decided to make these changes and you had to divide those **10 points** between **1) the influence of the [BOC_BPI] training program** and **2) all other influencing factors**, how many points would you give to each?

PI = AVERAGE (A1, A6_OTHER FACTORS)/10

QUANTITY (PQ)

A4. If you had not received the training, would your company have made the same number of changes or fewer?

1.	Company would have made the same number of changes	→ Q=1
2.	Company would have made fewer changes	→ REFER TO A4a
98.	Don't know	→ Q=1

A4a. Would your company have made slightly fewer, significantly fewer, or no changes at all?

1.	Slightly fewer changes	→Q=0.75
2.	Significantly fewer changes	→Q=0.5
3.	No changes at all	→Q=0
98.	Don't know	→Q=1

Timing (PT)

A2. Did information you learned from the training result in making any of these changes earlier than they would have been made, had you <u>NOT</u> attended the training?

1.	Made changes earlier than would have without the training	→ REFER TO Q10B
2.	The training did not change the timing of the changes	→ T=1
3.	Would not have made changes at all without the training.	→ T=0
98.	Don't know	→ T=1

A3. If your company would have made these changes without you receiving the training, when do you think it would have happened?

1.	At roughly the same time	→ T=1
2.	Within six months	→ T=0.875
3.	Within a year	→ T=0.75
4.	Within 2 years	→ T=0.625
5.	More than 2 years	→ T=0.5
98.	Don't know	→ T=1

Appendix G. Additional Documents

Below is a memo summarizing our findings from the PA interviews.

PA Interview Findings

Below is the participant survey instrument

MF Training Internet Survey

Below are the in-depth interview guides used for the four case studies.

Case Study One Guide

Case Study Two Guide

Case Study Three Guide

Case Study Four Guide

Appendix H. Study Recommendations

Table 49. Study Recommendations in IESR Format

Study ID	Study Type	Study Title	Study Manager			
ED_O_WET_3	Impact and Non-Energy Outcomes	2013–2015 Multifamily Property Manager Training: Impact and Outcome Study	CPUC			
Recommendation	**Program or Database**	**Summary of Findings**	**Additional Supporting Information**	**Best Practice/Recommendations**	**Recommendation Recipient**	**Affected Workpaper or DEER**
1	Multifamily Whole Building Program	Through we found some evidence that the BOC training includes some MF staff, the BOC training primarily targets commercial building operators. Further, NEEC does not have the data tracking systems in place to properly identify multifamily participants.		We recommend that future research focus specifically on BPI MFBO training, as this is a training attended predominately by multifamily building owners, managers, and maintenance staff. Should the CPUC and/or NEEC seek to determine the energy savings potential of BOC training in the multifamily sector, additional data tracking will be necessary to identify multifamily participants. Most importantly, NEEC should consider including an identifier flag in the data that indicates whether a participant oversees or maintains a multifamily property. With this data, future evaluations can identify MF staff by looking for "multifamily" participants in the "property management" or "other" categories.	CPUC/IOUs/NEEC	

Study ID	Study Type	Study Title	Study Manager			
ED_O_WET_3	Impact and Non-Energy Outcomes	2013–2015 Multifamily Property Manager Training: Impact and Outcome Study	CPUC			
Recommendation	**Program or Database**	**Summary of Findings**	**Additional Supporting Information**	**Best Practice/Recommendations**	**Recommendation Recipient**	**Affected Workpaper or DEER**
2	Multifamily Whole Building Program	Lack of interest or time among multifamily staff to participate in research, regardless of the incentive offered, is a known challenge in the industry and was a significant limitation for this study.		Before any further research is conducted, we recommend that the CPUC and IOUs collaborate with multifamily program implementers, training providers (e.g., AEA and NEEC), and other industry organizations to identify improved strategies to engage and motivate multifamily staff to participate in research (e.g., survey mode, survey length, outreach methods, incentive types and levels, best times to contact them, etc.). These types of organization can provide expertise on outreach strategies to this sector and can serve as credible messengers for research efforts.	CPUC/IOUs	

Study ID	Study Type	Study Title	Study Manager
ED_O_WET_3	Impact and Non-Energy Outcomes	2013–2015 Multifamily Property Manager Training: Impact and Outcome Study	CPUC

Recommendation	Program or Database	Summary of Findings	Additional Supporting Information	Best Practice/Recommendations	Recommendation Recipient	Affected Workpaper or DEER
3	Multifamily Whole Building Program	Additional research is needed to fully understand the MF O&M training needs and market		This study was intended to understand the motivations and benefits to O&M training among training participants and their companies. The study also gathered insights from multifamily program implementers to understand potential O&M training needs in the market. The next step would be to get a full picture of O&M training needs and barriers to getting training in the multifamily market by including MF staff who have not received any O&M training. This research should also explore whether the BPI MFBO and/or BOC's list of course topics align with those needs. For example, some systems (e.g., boilers and chillers), may not be applicable to the majority of California multifamily properties.	CPUC/IOUs	
4	Multifamily Whole Building Program	Additional research is needed to fully understand the most cost-effective approach to providing MF O&M training.	.	The CPUC should compare the costs of providing additional O&M marketing, education and outreach (ME&O) to the costs of incentivizing BOC/BPI training. Marketing might be a more cost-effective alternative.	CPUC/IOUs	

For more information, please contact:

Alan Elliott
Principal Consultant

510 214 0180 tel
510 444 5222 fax
aelliott@opiniondynamics.com

1 Kaiser Plaza, Ste 445
Oakland, CA 94612